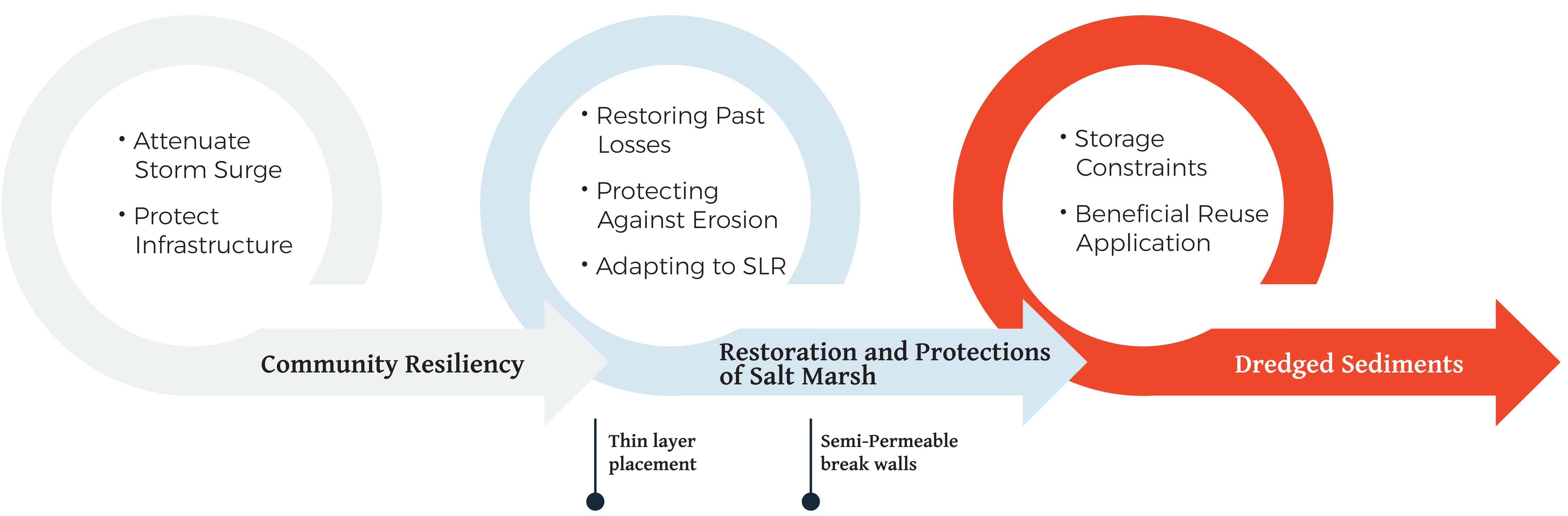
Thin Layer Placement of Dredged Sediments to Restore and Provide Resiliency to Salt Marsh Habitat

Christine Angelini[1], Jennifer Sagan[2], Greg Corning[2], John Kiefer[2], Orlando Cordero[1], Patrick Norby[1], Tracey Schafer[1], and Todd Osborne[1]

[1]University of Florida, [2]WSP USA Environment & Infrastructure

Project Goals

The goals of this project were to gather baseline data and develop preliminary engineering plans for a project that would allow stakeholders to evaluate a thin-layer placement (TLP) and semi-permeable barrier for vessel wake dissipation strategy that would 1) use locally dredged sediments to augment marsh elevation, 2) facilitate lateral expansion of salt marshes, and 3) reduce flood risk to critical community infrastructure (i.e., St Augustine wastewater treatment plant, Flagler hospital, and state road 312, a critical evacuation route) along the Matanzas River near Fish Island in the City of St Augustine, Florida.



The Problem

Lines of Evidence of Salt Marsh Loss

1. *GTMNERR Sediment Elevation Tables (SET) data demonstrate sea level rise is outpacing salt marsh rate of sediment accretion*
2. *Lateral erosion (up to 1 m/year) of salt marshes along the Intracoastal Waterway (ICW) across the entire county (Silliman et al. 2019)*
3. *Loss of 9,000 acres of salt marsh in Northeast Florida (Dix et al. 2021)*
4. *Photointerpretation of 2005 – 2021 confirming shoreline retreat*
5. *Terrestrial Laser Scans measuring shoreline retreat*
6. *Photointerpretation of historical aerial photography (1952) demonstrating loss of 100 acres*
7. *Groundtruthing of low vegetation densities in "drowning areas"*
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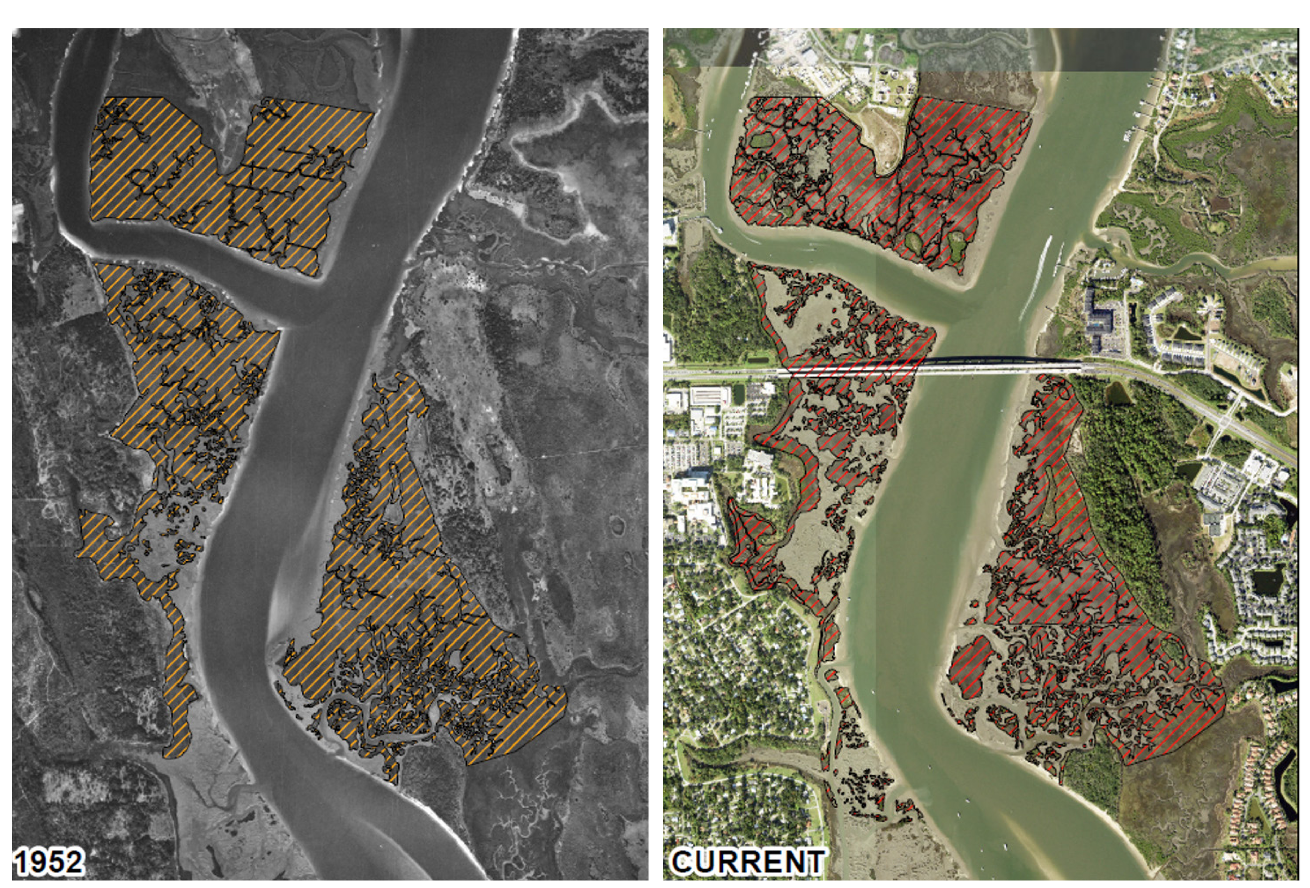

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Dix, N., R. Brockmeyer, S. Chapman, C. Angelini, S. Kidd, S. Eastman, & K. R. Radabaugh. 2021. Northeast Florida. In K. R. Radabaugh, C. E. Powell, and R. P. Moyer (Eds.). Coastal Habitat Integrated Mapping and Monitoring Program Report for the State of Florida. Florida Fish and Wildlife Conservation Commission. FWRI Technical Report No. 21, Version 2. **Department of the Army, U.S. Army Corps of Engineers**. 2002. Engineering and Design Coastal Engineering Manual. **Gailani**, J., Brutsché, K.E., Hartman, M.A., Godsey, E., Wang, P. 2019. Strategic Placement For Beneficial Use of Dredged Material. **Kurth**, H.M., Ali, R., Bridges, T.S., Suedel, B.C., and Linkov, I. 2020. Evaluating Resilience Co-benefits of Engineering with Nature® Projects. *Frontiers in Ecology and Evolution* 8:149. **MacDonald**, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters Volume 2 - Application of the Sediment Quality Assessment Guidelines. **Mohan**, R., Piercy, C., and Welp, T. 2021. Engineering, Construction, and Best Management Practices for TLP Projects. Western Dredging Association Conference. **Myszewski**, M., Alber, M. 2017. Use of Thin Layer Placement of Dredged Material for Salt Marsh Restoration. **Raposa**, K., Wasson, K., Nelson, J., Fountain, M., West, J., Endris, C., Woolfolk, A. 2020. Guidance for thin-layer sediment placement as a strategy to enhance tidal marsh resilience to sea-level rise. Published in collaboration with the National Estuarine Research Reserve System Science Collaborative. **Silliman**, B.R., He, Q., Angelini, C., Smith, C.S., Kirwan, M.L., Daleo, P., Renzi, J.J., Butler, J., Osborne, T.Z., Nifong, J.C., de Koppel, J. (2019) Field experiments and meta-analysis reveal wetland vegetation as a crucial element in the coastal protection paradigm. *Current Biology*, 29:11, 1800-1806. **VanZomeren**, C.M., Piercy, C.D. 2019. Thin Layer Placement of Sediments for Restoring Ecological Function to Salt Marshes: A Quantitative Review of Scientific Literature. DOER Technical Notes Collection. ERDC/TN DOER-E44. Vicksburg, MS: U.S. Army Engineer Research and Development Center. **Walkup**, C. J. 1991. *Spartina alterniflora*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Planning

Donor Sediment Source

Seven Dredge Material Management Areas (DMMA), into which intracoastal waterway (ICW) sediments are stored, are located within St. Johns and Duval Counties. DMMA site SJ-14 is one of the closets sites to the project (18 miles) and contains over 1,000,000 cubic yards of ICW sediments, far more than the needs of the project. Sediment data from the DMMA site were compared with the salt marsh site data. For contaminant assessments, concentrations were compared against FDEP's ecological and human health regulatory criteria. The FDEP Coastal Sediment Quality Assessment Guidelines (MacDonald 1994) provide Threshold Effects Levels or contaminant concentrations below which biological effects are not expected. The Soil Clean up Target Levels (SCTL) provide regulatory guidelines for contaminant concentrations below which human health should be not affected. Of all the contaminants tested, only arsenic and cadmium had concentrations that exceeded either human health or ecological criteria. Exceedances were only found in marsh sediments and were not found in DMMA sediments.

A comparison of physical characteristics was conducted between DMMA and marsh sediments. Both DMMA and marsh sediments showed grain size distributions that generally followed %sand > %silt > %clay. DMMA sediments showed higher percentage of sand (96 – 98%) and lower percentages of silt (1 – 3%) and clay (1%) than the marsh sediments, 27 - 91%, 7 – 63%, and 2 – 17%, respectively. Physical and chemical analyses of sediment samples from the DMMA confirmed that ICW sediments will support thin-layer placement and semi-permeable barrier construction.

Marsh Elevation Targets

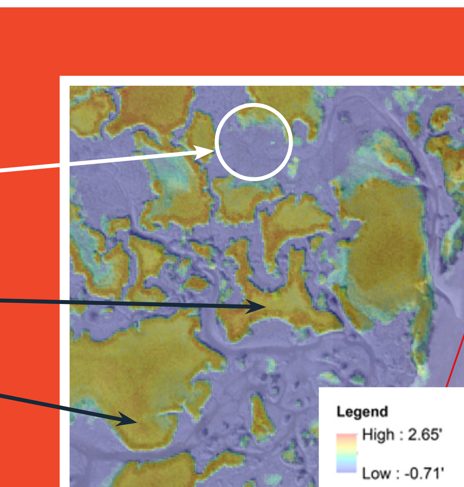
Target elevations were derived from in-field observations and literature review (VanZomeren and Piercy 2020; Walkup 1991) of preferred elevations of *Spartina alterniflora*, the dominant marsh grass occupying the low marsh habitat at the site. Low marsh habitats are identified as between mean low tide and mean high tide. Locally obtained tidal data put mean high tide elevations at 1.66 ft (NAV88). LiDAR dated 2014 and developed by NOAA's National Centers for Environmental Information (NCEI) was used to confirm elevations at which dense, healthy assemblages of *S. alterniflora* were located in field plots. A target elevation of 1.66 ft was used for sediment application elevations.

Plot_ID	Zone	Date	Species	Braun_Blaunquet	Elevation (ft)
1B4	1.000000	8/6/2021	Spartina alterniflora	5	1.79
1D2	1.000000	8/6/2021	Spartina alterniflora	5	1.62
1C1	1.000000	8/9/2021	Spartina alterniflora	5	1.50
1C3	1.000000	8/9/2021	Spartina alterniflora	5	1.67
6D3	6.000000	8/20/2021	Spartina alterniflora	5	1.64
6A7	6.000000	9/2/2021	Spartina alterniflora	5	1.46
6A9	6.000000	9/2/2021	Spartina alterniflora	5	1.71

Sediment Application and Thickness

In review of the physical characteristics of the DMMA sediment, sediment loss where historical photography depicted salt marsh, interior marsh areas experiencing drowning, sea level rise, and the target elevations for marsh success, we identified the following three locations for thin layer placement of sediments for salt marsh restoration: 1) The 100 acres of lost 1952 salt marsh footprint now occupied by mudflat and oyster bars; 2) Interior areas within marsh patches that are "drowning"; and 3) Marsh-wide application of sediment to counteract sea level rise (SLR). Locations where laterally eroding shoreline were shown to be most advanced, were also used to determine placement of semi-permeable wavebreaks.

- Calculate depth of fill to convert mud flat back to *S. alterniflora* elevations - 18 inches
- Establish depth of fill to elevate "drowning" areas of existing *S. alterniflora* - 3 - 6 inches
- Add additional sediment to give lift for future SLR - 1 inch



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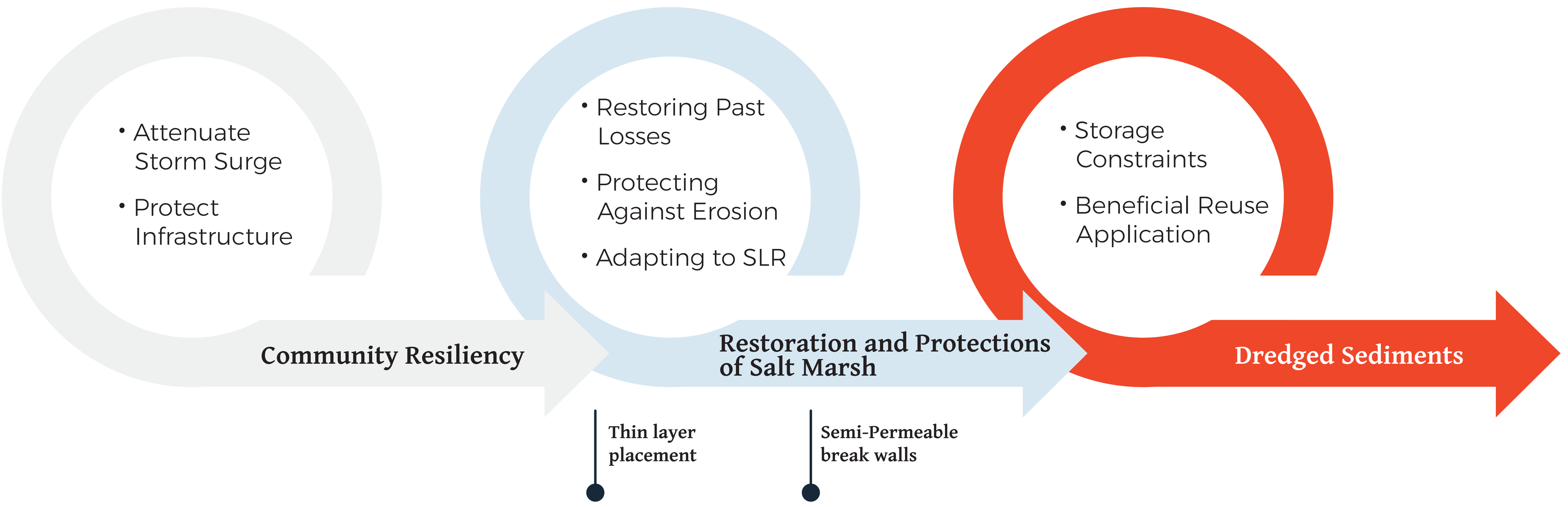

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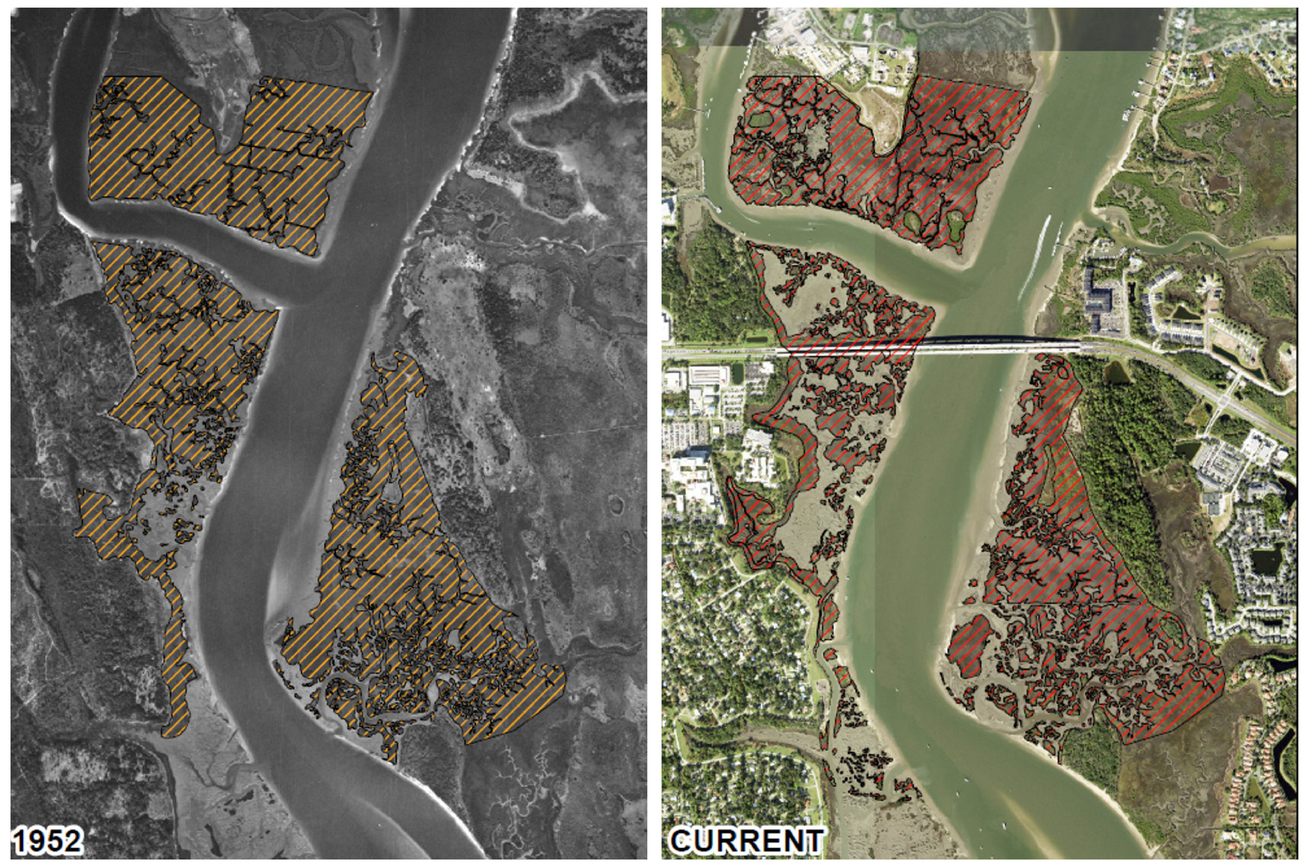

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