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NWP, Life Cycle Cost Analysis of RSM Strategies, Norton/Piercy

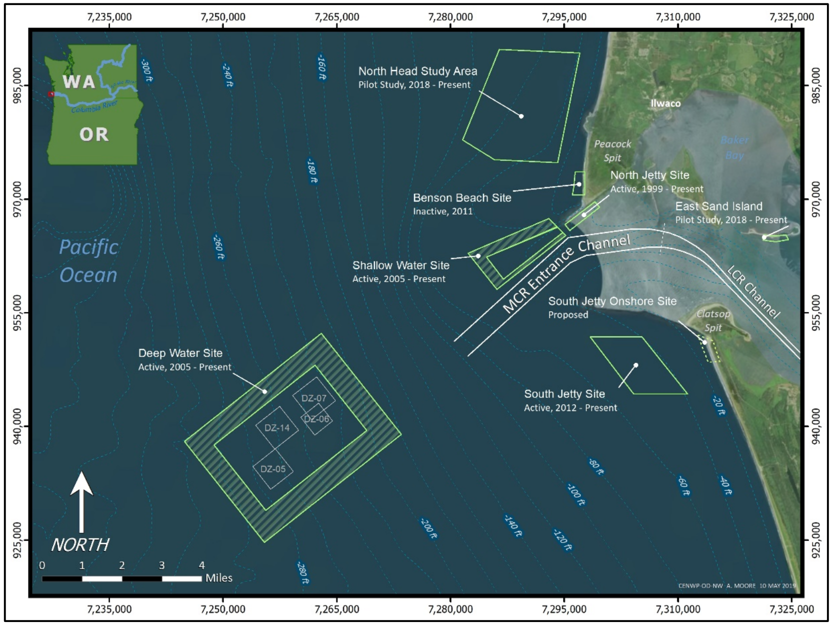
BLUF: Using a life-cycle analysis approach to fully account for costs and benefits of RSM strategies across multiple maintenance dredging cycles will reveal hidden costs and benefits at a programmatic level that may not be accounted for in a per-cycle analysis.

Challenge/Objectives

- Determine the dredging cost savings of RSM approaches at the Mouth of the Columbia River and Coos Bay over multiple dredging cycles
- Identify and quantify indirect benefits of sustained nearshore placement

Approach

- Compile dredge data from multiple dredging cycles
- Analyze cycle and transit times for placement at nearshore and deep water sites
- Identify and estimate quantifiable indirect benefits of nearshore placement



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District/Other USACE PDT Members

Sam Fielding – ERDC Knauss Fellow

Kate Groth (NWP RSM Program Manager)

Terry Geroux (Dredging Contracts Team Lead) Travis Davidson (Resident Engineer)

Rod Moritz (Hydraulic Engineer)

Rachel Stolt (Hydraulic Engineer)

Austin Hudson (Hydraulic Engineer)

Adam Mamrak (Cost Engineer)

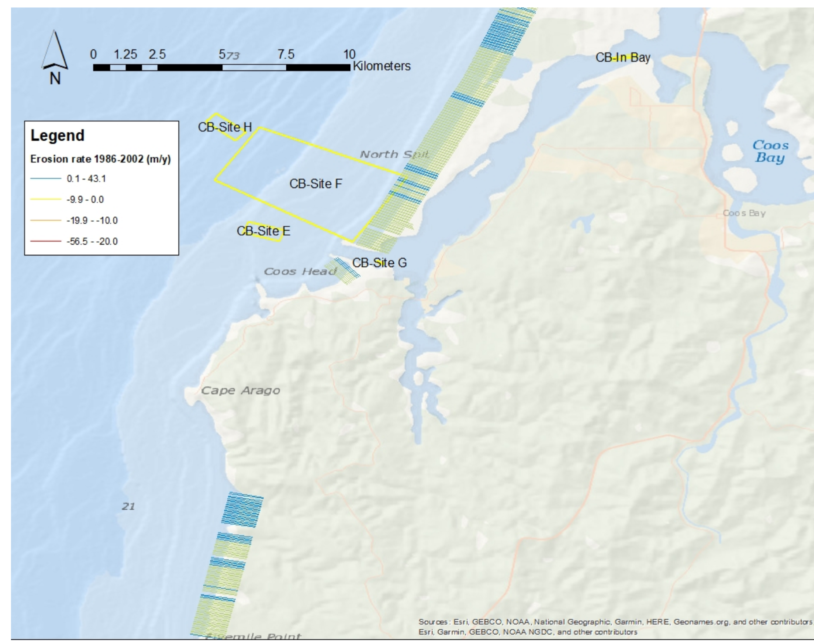
Leveraging/Collaborative Opportunities

This is a complementary effort to the RSM program work to more fully capture tangible benefits of past RSM projects.

This project would only be possible with the continued investment in RSM practices at MCR and Coos Bay.

Stakeholders/Partners

NOAA, USGS, EPA, DOE, DEQ, DLCD, WDFW, ODFW, DOGAMI, Columbia River Bar Pilots, Port of Ilwaco, Port of Chinook, Oregon State University, CRCFA, others



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Accomplishments/Deliverables

- Initial analysis of dredge data complete
- Method to link placement volumes to potential reduction in erosion rates to other benefits (e.g., change in coastal vulnerability, avoided shoreline protection costs, recreation benefits

Lessons Learned

- Many factors affect dredge cycle times – must break down into separate components
- Translation of nearshore placement to benefits realized requires numerous assumptions

Year	Disposal Area	Dredge	Transit mean	Transit median	Cycle mean	Cycle median	Prod Rate mean	Prod Rate median	CY mean	CY median
2015	DWS	Bayport	58.3	59	134.5	131	26.9	27.1	3549.2	3586
2015	DWS	ESSAYONS	93.9	94	205.3	202	27.7	27.7	5538.4	5599
2015	NJS	Bayport	16.4	13	90.3	79	43.6	46.7	3664.4	3693
2015	SJS	ESSAYONS	80.1	76.5	195.7	191.5	28.9	27.9	5472.6	5518
2015	SWS	Bayport	15.8	15	91.9	84	41.7	43.6	3632.0	3666
2016	DWS	Bayport	65.6	66	135.4	131	26.0	26.6	3464.8	3452
2016	DWS	ESSAYONS	95.8	96	215.7	213	26.4	25.9	5549.6	5644
2016	NJS	Bayport	16.7	13.5	78.8	72	44.9	46.7	3381.4	3505
2016	SJS	ESSAYONS	78.1	77	192.8	183	30.2	30.4	5654.5	5690
2016	SWS	Bayport	17.2	17	88.7	81	42.0	44.3	3542.5	3559
2017	DWS	ESSAYONS	93.7	91.5	214.0	213	26.8	26.7	5616.6	5732.5
2017	DWS	Terrapin_Island	53.5	50.4	100.6	99.3	35.2	35.4	3495.7	3480
2017	NJS	Terrapin_Island	17.8	15	71.9	61.6	51.0	53.9	3377.7	3410
2017	SJS	ESSAYONS	68.1	67	231.7	235.5	25.6	24.4	5563.8	5637
2017	SWS	Terrapin_Island	19.1	17	72.0	66	50.4	51.3	3407.9	3430
2018	DWS	ESSAYONS	88.6	87	202.3	199	28.5	28.0	5577.2	5621.5
2018	DWS	Stuyvesant	68.2	66	218.0	221		34.7	7278.2	7582
2018	NJS	Stuyvesant	25.4	23	221.8	196	36.6	38.3	7462.0	7582
2018	SJS	ESSAYONS	60.4	59	198.2	190	29.8	30.2	5659.5	5689
2018	SWS	Stuyvesant	20.7	20	228.4	204.5	38.3	38.8	7960.5	7994
2019	DWS	Bayport	66.3	66.2	141.6	136.4	22.9	23.9	3170.4	3197.5
2019	DWS	ESSAYONS	87.7	85	211.5	207	26.2	26.4	5376.4	5656
2019	NJS	Bayport	16.0	15	90.0	81.3	42.0	43.1	3549.1	3599.5
2019	SJS	ESSAYONS	62.9	59.5	184.7	180	31.3	30.4	5587.9	5655.5
2019	SWS	Bayport	18.1	16.2	89.7	83	42.2	43.7	3604.8	3639

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What challenges did you face to get your project to implementation and how did you move past them?

- Analyzing dredge data is messy! Comparing data from government versus contract dredges adds another layer of complexity
- Quantitative analysis of indirect benefits requires integration of many types of data and requires many assumptions about nearshore placement efficiency

Coastal vulnerability (from InVEST)

Example Ranking System

Rank	1 (very low)	2 (low)	3 (moderate)	4 (high)	5 (very high)
Geomorphology	Rocky; high cliffs; fjord; fiard; seawalls	Medium cliff; indented coast; bulkheads and small seawalls	Low cliff; glacial drift; alluvial plain; revetments; rip-rap walls	Cobble beach; estuary; lagoon; bluff	Barrier beach; sand beach; mud flat; delta
Relief	81 to 100 Percentile	61 to 80 Percentile	41 to 60 Percentile	21 to 40 Percentile	0 to 20 Percentile
Natural Habitats	Coral reef; mangrove; coastal forest	High dune; marsh	Low dune	Seagrass; kelp	No habitat
Sea Level Change	0 to 20 Percentile	21 to 40 Percentile	41 to 60 Percentile	61 to 80 Percentile	81 to 100 Percentile
Wave Exposure	0 to 20 Percentile	21 to 40 Percentile	41 to 60 Percentile	61 to 80 Percentile	81 to 100 Percentile
Surge Potential	0 to 20 Percentile	21 to 40 Percentile	41 to 60 Percentile	61 to 80 Percentile	81 to 100 Percentile

Table 4.1: List of Bio-Geophysical Variables and Ranking System for Coastal Exposure.

The model calculates the exposure index EI for each shoreline point as the geometric mean of all the variable ranks:

$$EI = (R_{Geomorphology} R_{Relief} R_{Habitats} R_{SLR} R_{WindExposure} R_{WaveExposure} R_{Surge})^{1/7} \quad (1)$$

or more generally:

$$EI = \left(\prod_{i=1}^{n} R_i\right)^{1/n} \quad (2)$$

Recreation and Tourism (from InVEST)

Predicted using the surrogate variable "photo user days"

Example Predictor Table

id	path	type
ports	dredged_ports.shp	point_count
airdist	airport.shp	point_nearest_distance
beaches	beaches.shp	line_intersect_length
bonefish	bonefish.shp	polygon_percent_coverage
roads	roads_simple_buf.shp	polygon_percent_coverage
elevation	dem90m.tif	raster_mean

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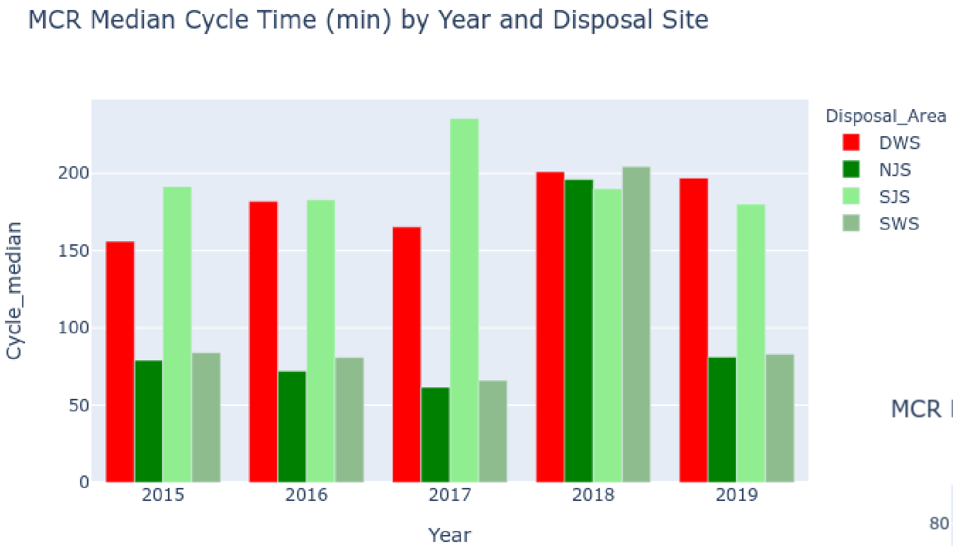
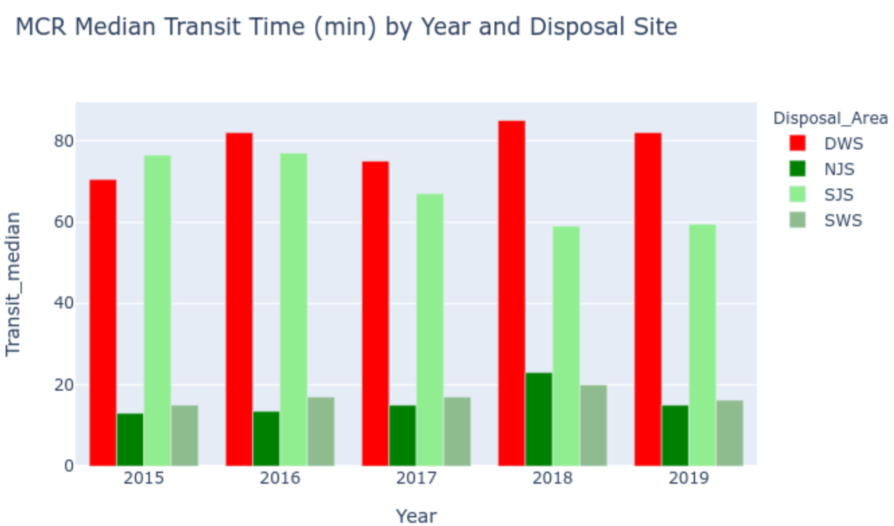
How is this project benefiting the USACE and Nation?



The North Jetty and Shallow water sites produce large reductions in cycle time largely linked to transit time. Together these lead to increases in production rates.



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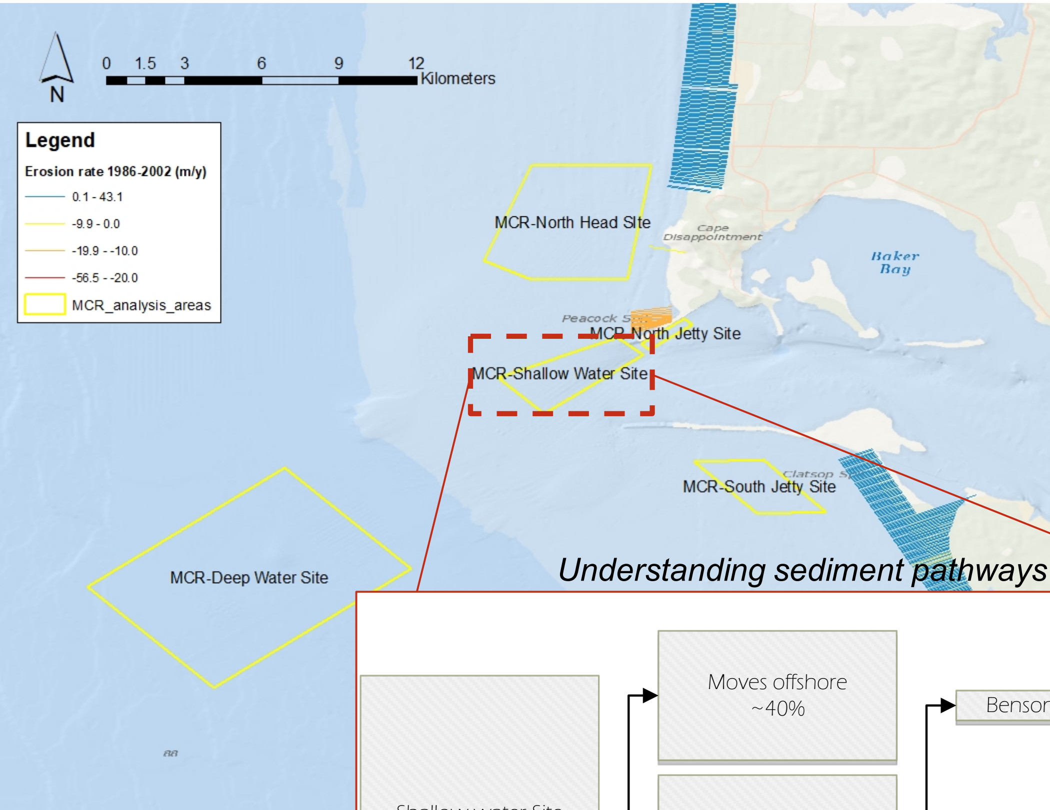
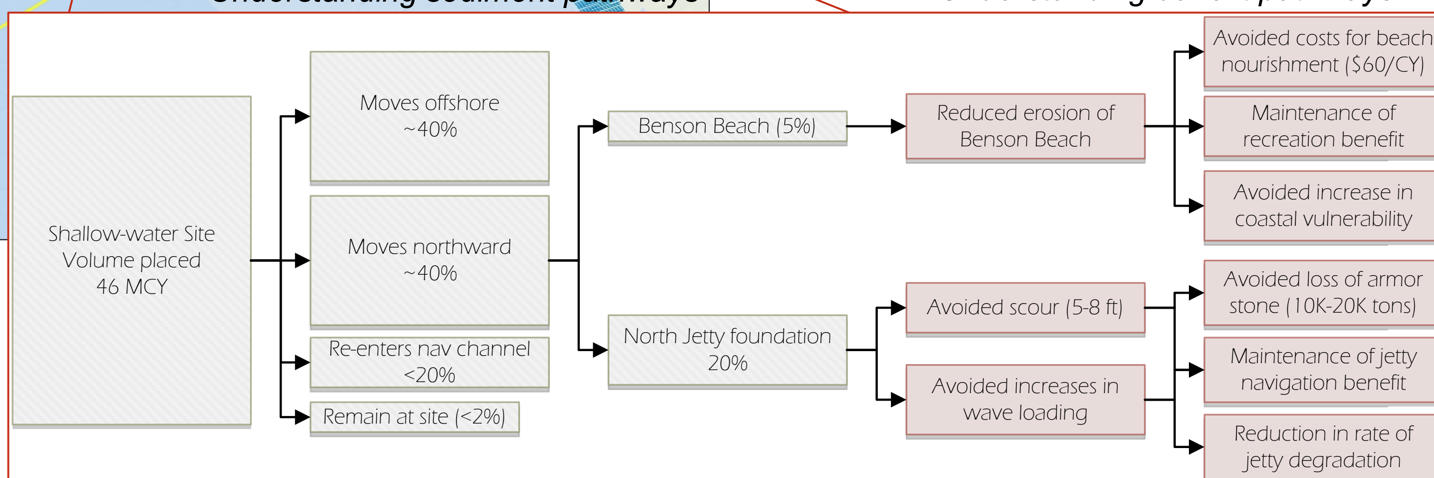


How is this project benefiting the USACE and Nation?

Understanding sediment pathways

Understanding benefit pathways



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How is this project benefiting the USACE and Nation?

Benefits associated with nearshore placement of dredged material can have a low proportional relationship with the volume of sediment placed, compared to targeted onshore or pump-ashore placement.

Nearshore placement may have a benefit to volume ratio of 1:5 or 1:20 (i.e. 1 out of 5 cubic yards placed contributes to a net benefit). Pump-ashore or targeted placement may have benefit to volume ratio of 1:1.

It is noted that nearshore placement may be the default method for managing dredged material, and associated "placement" costs may be incidental to the dredging project. For progressively larger volumes of nearshore placement, accrued over time, a low "benefit to volume ratio" can have a significant cumulative positive effect.

In the above consideration, the low rate of realized benefits associated with nearshore placement may outperform the high cost of enhance benefit placement methods.

Example: Use of MCR-Shallow Water Site-SWS provides direct benefit to Benson Beach (reducing shoreline erosion/recession) based on 1:20 ratio. The equivalent beach nourishment benefit value for placement of dredged sand at SWS is estimated to be $3/cy. Similarly, the equivalent benefit of sand placement at SWS for protecting the foundation of the north jetty is $0.15/cy.