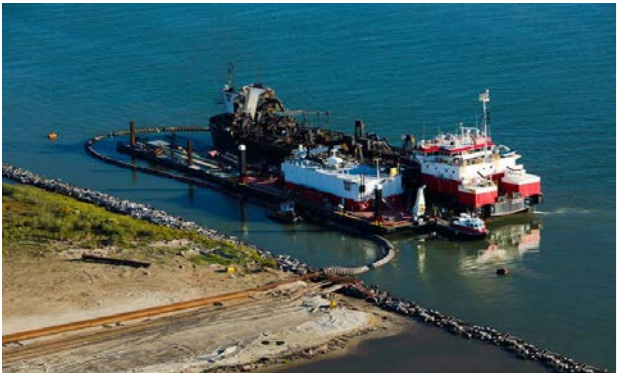
Economic and Geomorphic Comparison of Nearshore vs. OCS Sand for Coastal Restoration Projects



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State of The Coast
May 30, 2018 , New Orleans, Louisiana

BOEM
Bureau of Ocean Energy Management

LSU

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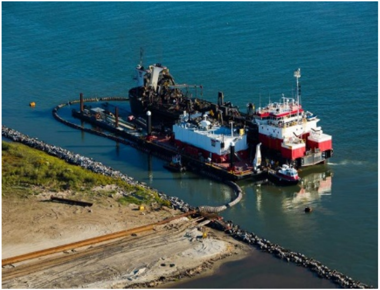
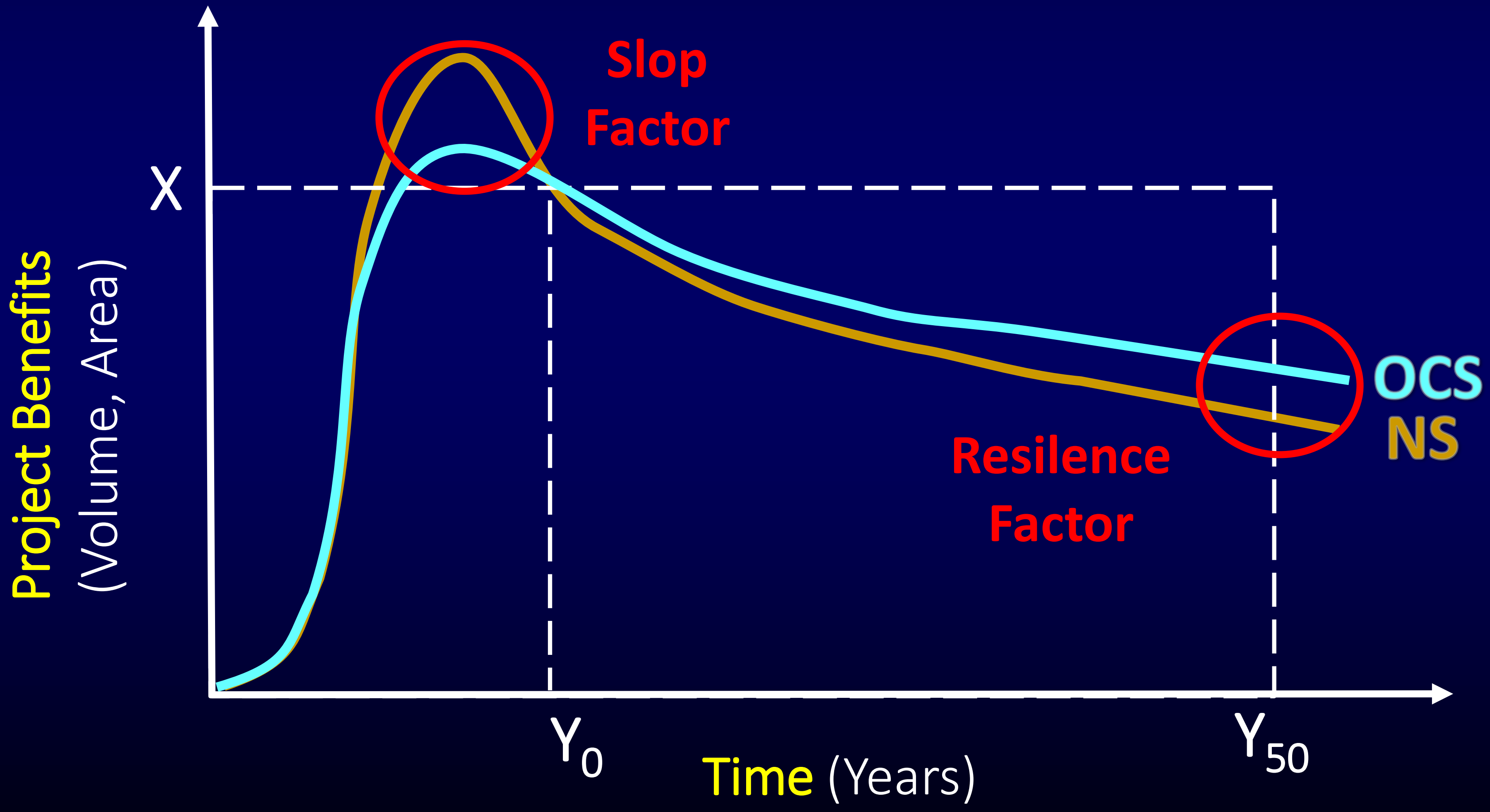


Trajectory Economics

What are the restoration tradeoffs between quantity, quality, and costs over time with risk?



Components and Structure of Project

- Cost Model
- Benefits Model
- Integrated Model
- Preliminary observations

Cost Modeling: Based on Historical Project Data

Scofield Island

Projects for OCS and NS Cost Modeling

1. BA-30 East Grand Terre Island Restoration
2. BA-35 Pass Chaland to Grand Bayou Pass Barrier Shoreline Restoration
3. BA-38-1 Pelican Island Restoration
4. BA-38-2 Chaland headland Restoration
5. BA-40 Riverine Sand Mining/Scofield Island Restoration
6. BA-45 Caminada Headland Beach and Dune Restoration
7. BA-76 Cheniere Ronquille Barrier Island Restoration
8. BA-110 Shell Island East BERM Restoration
9. BA-111 Shell Island West NRDA Restoration
10. BA-143 Caminada Headland Beach and Dune Restoration INCR2
11. CS-31 Holly Beach Sand Management
12. CS-33 Cameron Parish Shoreline Restoration
13. TE-20 Isles Dernieres Restoration East Island
14. TE-24 Isles Dernieres Restoration Trinity Island
15. TE-27 Whiskey Island Restoration
16. TE-25&30 East Timbalier Island Sediment Restoration
17. TE-37 New Cut Dune and Marsh Restoration
18. TE-40 Timbalier Island Dune and Marsh Creation
19. TE-48-2 Raccoon Island Shoreline Protection and Marsh Creation
20. TE-50 Whiskey Island Back Barrier Marsh Creation
21. TE-52 West Belle Pass Barrier Headland Restoration
22. TE-100 Caillou Lake Headlands Restoration

Modeling Project Costs

Data Sources:

- Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA)
- Coastal Information Management System (CPRA)
- CPRA Annual Barrier Island status reports
- Commercial Sector
  Weeks Marine, Great Lakes Dredge & Dock, C.F. Bean,
  Manson, T.L. James, Bryd Bros, Central Gulf Dredging, etc.

Observations:

- Project Completion Reports (n=22)
- Project bids for restorations projects (n=71)

Descriptive Data: Nearshore (NS) vs. OCS

Source	Obs.	$/Acre	$/CuYd	Distance (Mile)	Cuyd/Acre
NS	32	71,187	$8.37	7.43	10,199
OCS	39	134,684	$14.31	11.06	9,235

Potential Cost Model Variables

Variable	**Description**	**Mean**	**Std.Dev**
Dependent Variables			
CC ($)	Construction Cost (2016 $)	4.13e+07	3.38e+07
Independent Variables			
CYD	Total Dredged Material (cubic yard)	3678946	1753443
MOB	Mobilization/Demobilization ($)	5348487	3910962
DIST	Average Distance from borrow site to project site (mile)	9.43	10.31
AD	Access Dredging/Channels ($)	57406	146225
NA	Net Acres Created (acre)	402	167
DUNE	Average Dune Elevation (feet)	6.39	1.20
TES	Threatened or Engangerd Species (Yes=1)	0.46	0.50
PROGRAM	Coastal Program (CWPPRA=1)	0.61	0.49
WEEKS	Bidder (WEEKS=1)	0.38	0.49
BP	Booster Pump (Yes=1)	1	0
PYT	Payment Type (Fill=1)	0.61	0.49
CUTTER	Dredge Equipment (Cutterhead=1)	0.86	0.35
RH	Re-handing (Yes=1)	0.27	0.45
OFFSHORE	Project Borrow Source Location (OCS=1)	0.55	0.50
		Percent	Cum.
BASIN	Coastal Basin		
	Calcasieu/Sabine=2	5.63	5.63
	Terrebonne=3	45.07	50.70
	Barataria=1	49.30	100

Construction costs is ultimately a function of quantity and distance

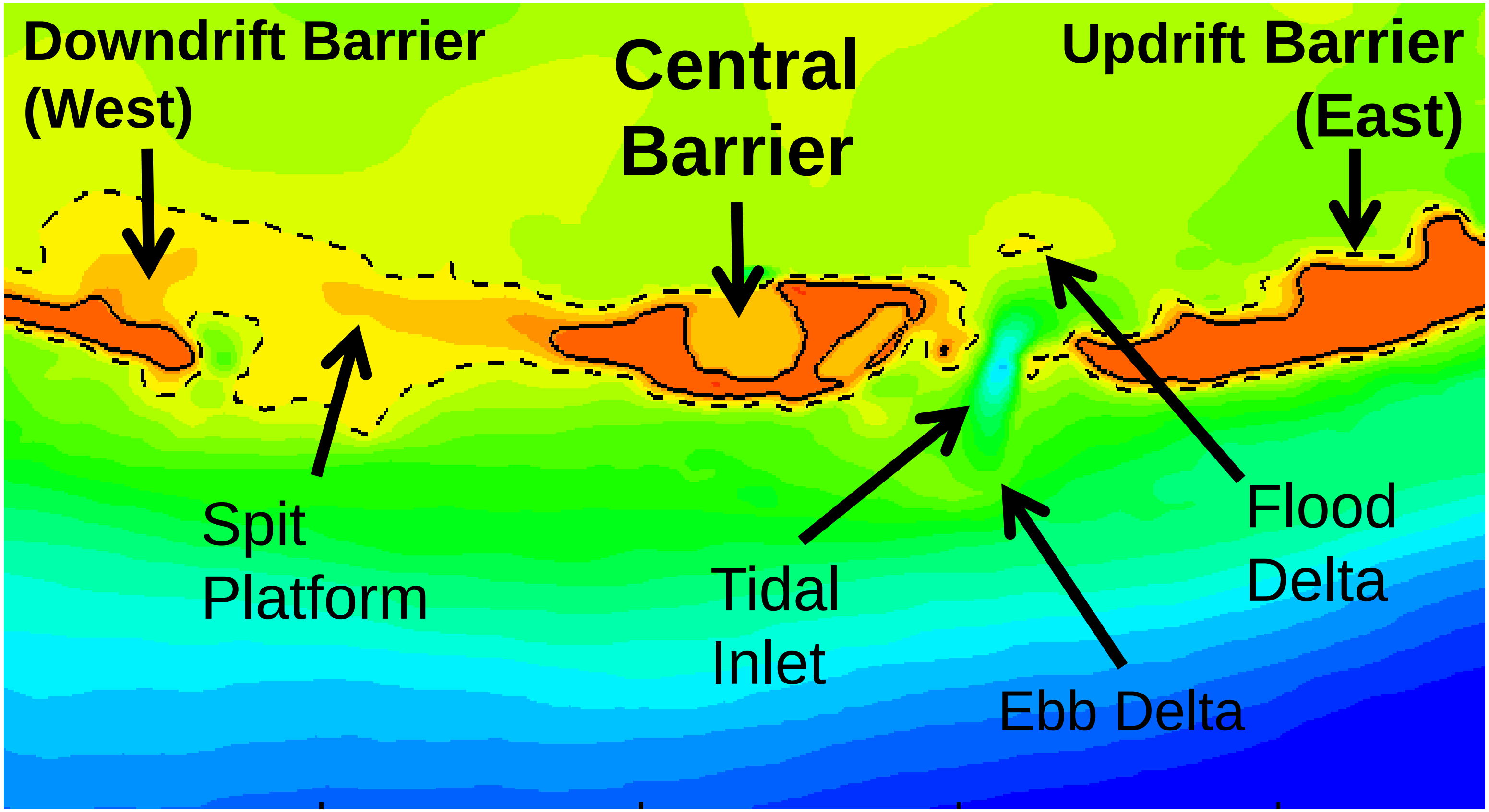
	Coef.	Std.Err.	t	P>|t|	95% Conf.Interval	
CYD	5854.336	1041.422	5.62	0.000	3782.617	7926.055
Distance	3301.997	969.7537	3.4	0.001	1372.848	5231.146
Distance^2	-59.88951	28.56021	-2.1	0.039	-116.705	-3.07416
Program_n 1	-10240.96	6852.879	-1.49	0.139	-23873.5	3391.595
2	5697.694	3112.825	1.83	0.071	-494.706	11890.09
4	64210.22	12233.62	5.25	0.000	39873.65	88546.78
5	8693.607	3377.576	2.57	0.012	1974.534	15412.68
6	-3931.343	4514.036	-0.87	0.386	-12911.2	5048.513
Dune Elevation	820.1013	1037.745	0.79	0.432	-1244.31	2884.507
Pay on fill	7983.267	3580.617	2.23	0.029	860.2798	15106.25
_cons	-15971.52	6636.243	-2.41	0.018	-29173.1	-2769.92

Linear Regression: N=93, R-square = 0.93,
F(10,82) = 79.52, Prob > F = 0.0000, Root MSE = 9179.3

Benefit Modeling: Based on Proxy Barrier System

Isle Dernieres - Trinity
(Shea Penland)

Proxy Barrier System



——— Barrier shorelines ~mean sea level (MSL)

- - - - - Subaqueous barrier ~1.25 m depth below MS

Geophysical Model Setup

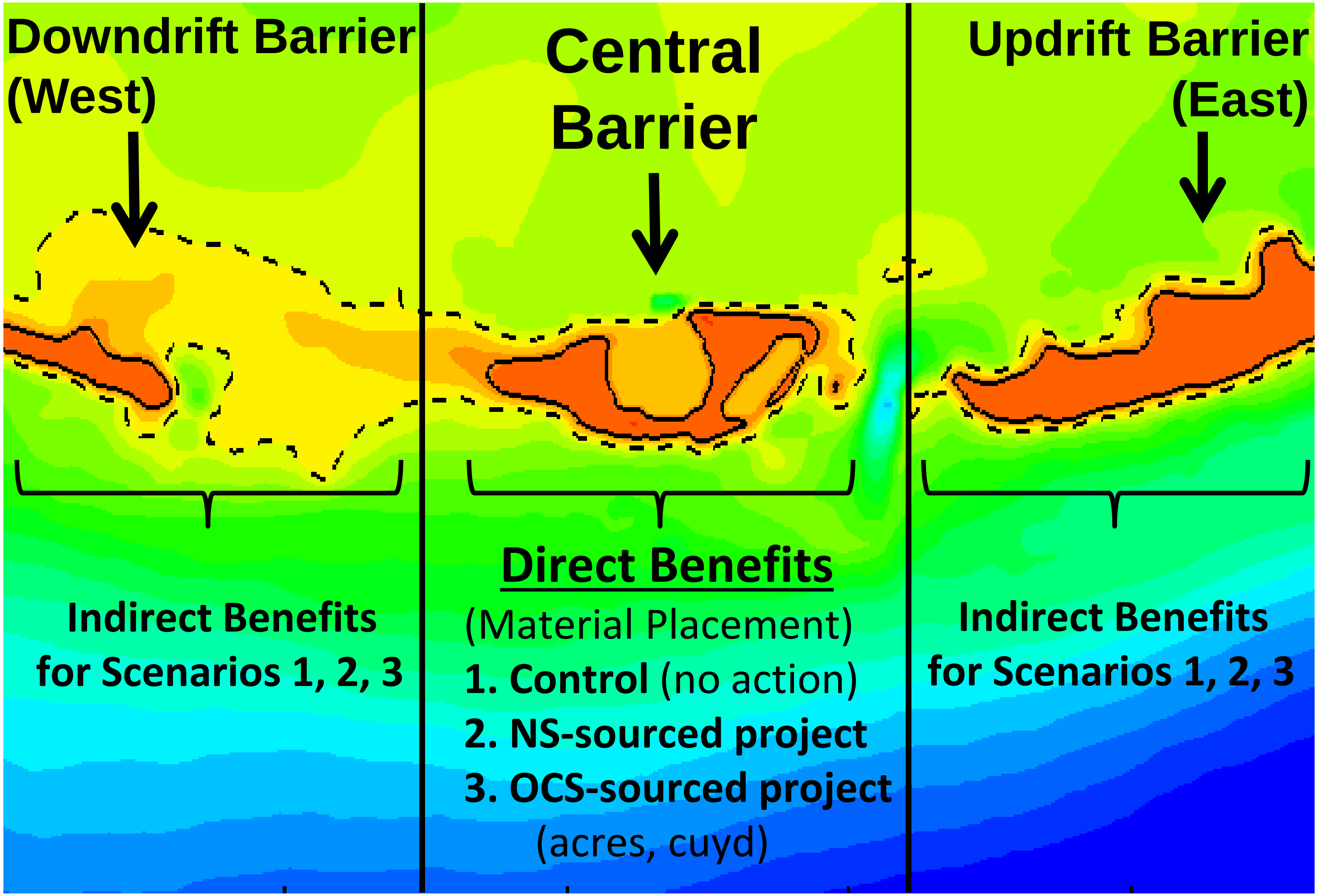
- Delft 3D-SWAN hydrodynamic and sediment transport model driven by tides, waves, storms and RSLR over a 192 x 384 grid of varying resolution (1 Km- 20m).

- Waves forced offshore ~6 hours (USACE-WIS), flow and waves coupled every 6 hours, RSLR changes from CPRA 2017.

- Sediment transport (van Rijn) with 2 sand classes to depict bathymetry updating (NS=156µm, OCS=160µm), morphodynamic upscaling, bed-load and suspended load transport (e.g. accounts for wash-over, breaching, lateral migration, sediment bypassing).

- Simulates sediment placement dynamics for *direct* and *indirect* effects across a closed template at 1.0, 0.0, and -0.5 meter contours (see SOC 2018 poster by: Kime, Georgiou, and Miner).

Basic Model Scenarios



Downdrift Barrier (West)

Central Barrier

Updrift Barrier (East)

Indirect Benefits for Scenarios 1, 2, 3

Direct Benefits

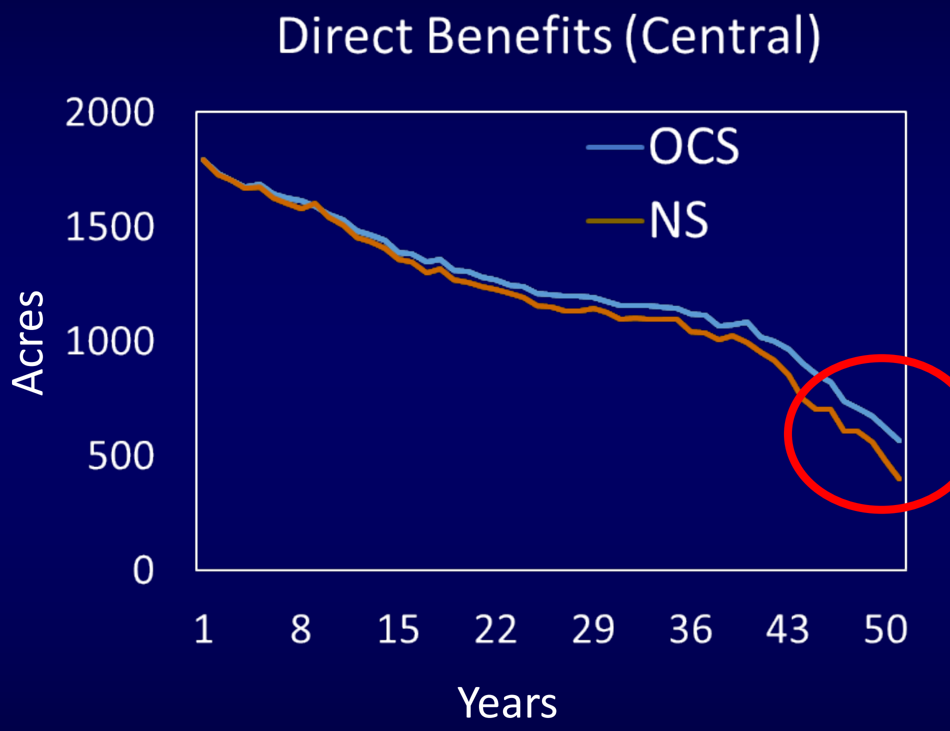
(Material Placement)

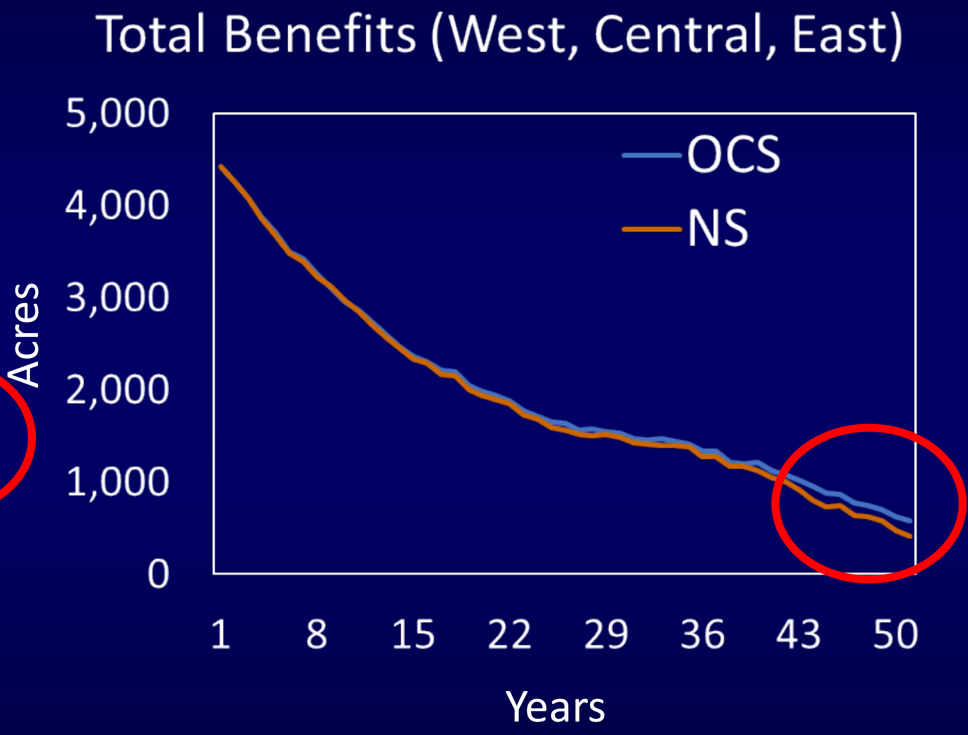
1. **Control** (no action)
2. **NS-sourced project**
3. **OCS-sourced project**

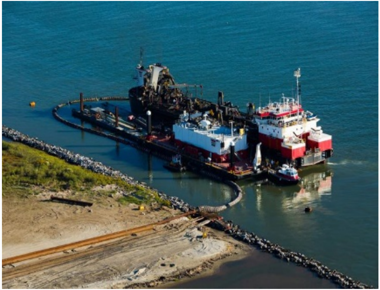
(acres, cuyd)

Indirect Benefits for Scenarios 1, 2, 3

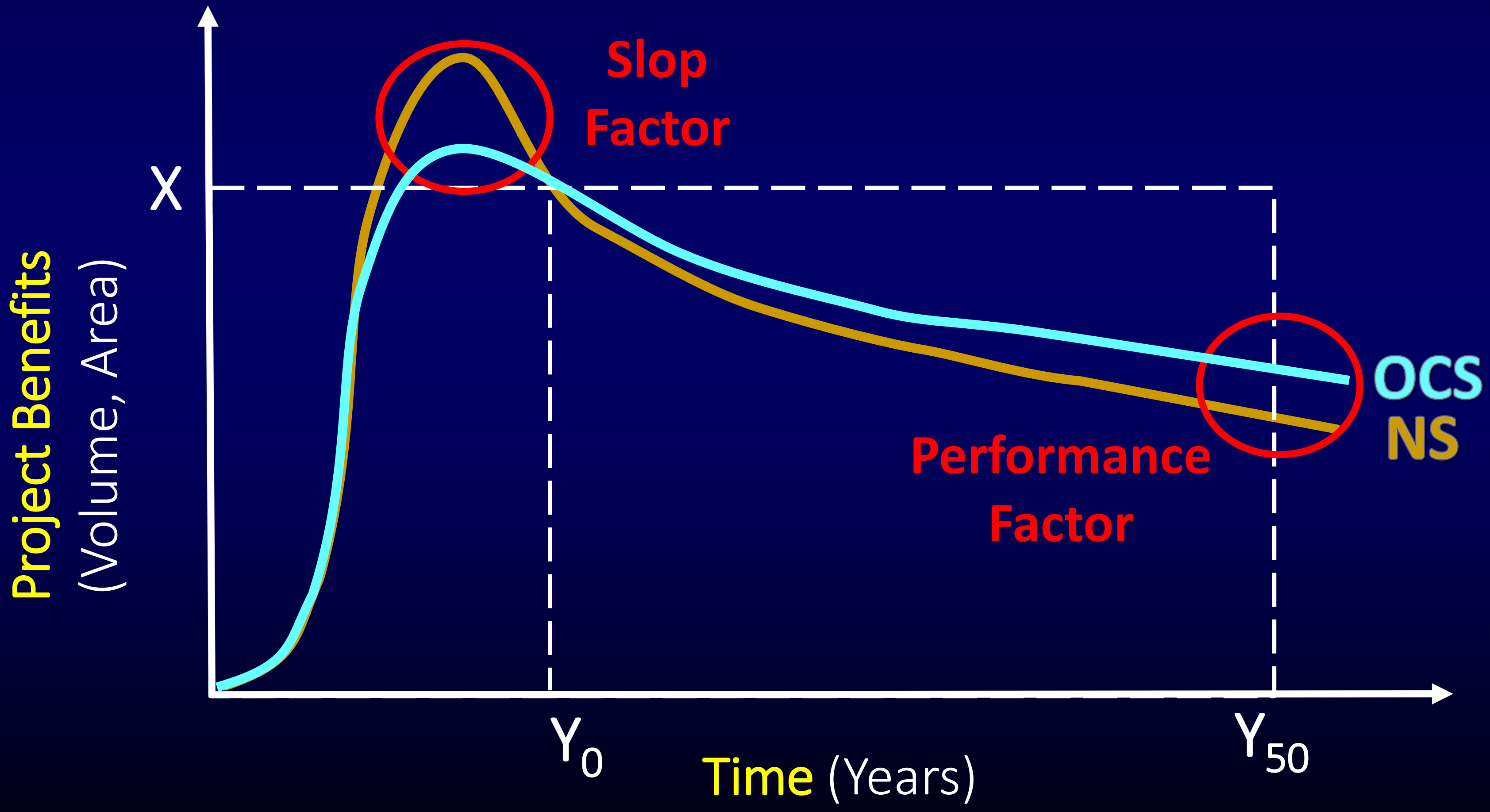
Geophysical Model Output


Direct Benefits (Central)


Total Benefits (West, Central, East)



Nearshore (NS) vs. OCS Sediments



Integrated Model: Based on Benefit-Cost Analysis

$$\text{C:E Ratio} = \frac{\text{Total Project Costs (\$)}}{\text{Total Project Benefits (units)}}$$

Ecosystem Services for NS vs. OCS =

Monetized Approaches

Net Present Value

$$NPV = \sum_{t=1}^{T} \frac{B_t - C_t}{(1+R)^t} = \sum_{t=1}^{T} \frac{B_t}{(1+R)^t} - \sum_{t=1}^{T} \frac{C_t}{(1+R)^t}$$

Where:

B_t is benefits in time t in $

C_t is costs in time t in $

R is the discount rate

t is the year (T=1-50y)

We know costs ($) and physical quantities (x) at any time *t* for both NS and OCS…but ecosystem service values (ESV) must be <u>specified</u> for different scenarios

Monetized Approaches

Break-Even Scenarios

$$\text{BC Ratio} = \sum_{t=1}^{T} \frac{B_t}{(1+R)^t} \Big/ \sum \frac{C_t}{(1+R)^t} = 1.0$$

Where:

B_t is benefit in time t in \$

C_t is cost in time t in \$

R is the discount rate

t is the year (T=1-50y)

Since we know costs (\$) and physical quantities (x) at time t, we can set B:C=1.0 and solve for the ESV (\$) required to "break-even" under different scenarios.

Coupled Model Mechanics

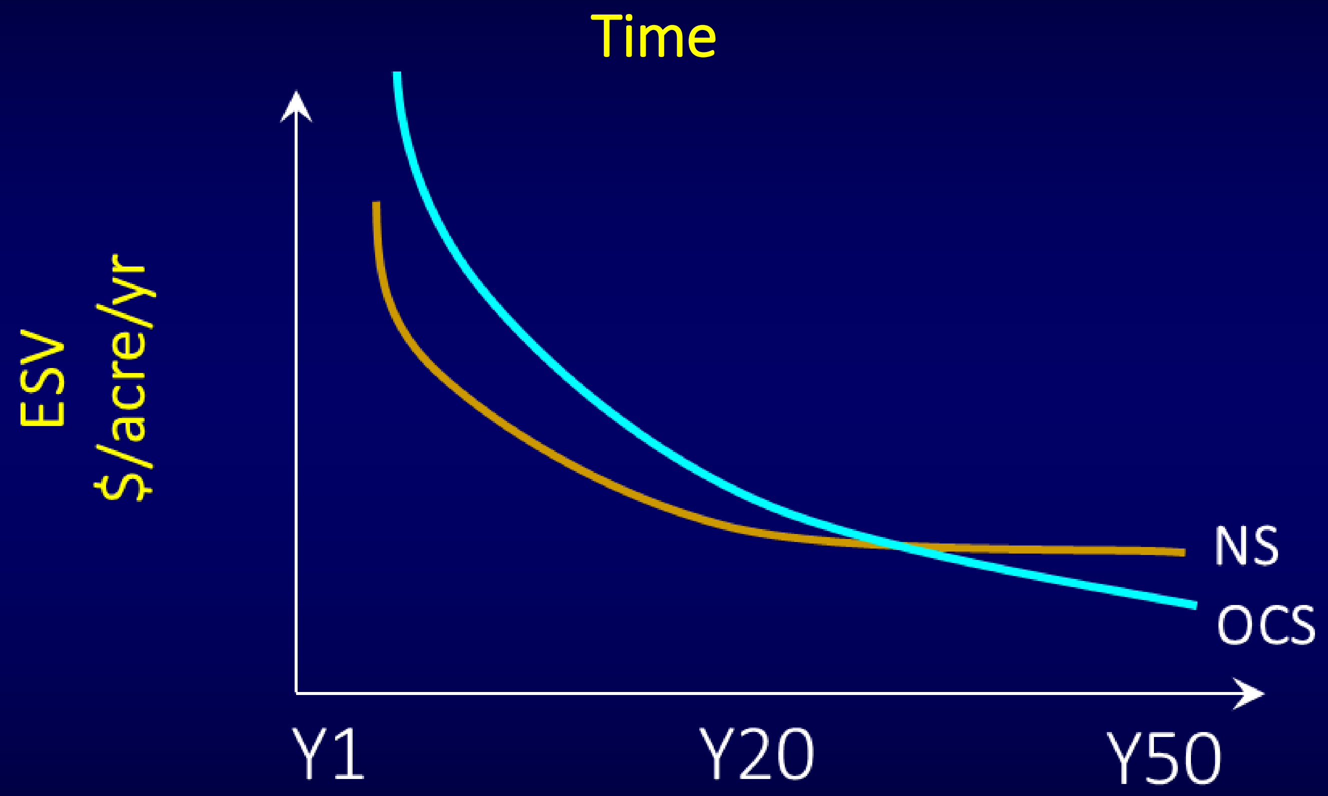
- Cost Model (NS and OCS data combined)
  - Function of sediment quantity, distance, program, payment type

- Benefit Models (NS, OCS)
  - Geophysical dynamics driven by sediment quality
  - Volume & acreage trajectories at *t* = 0, 1, 2, 3, ….50 years
    - Direct benefits (central)
    - System benefits (West, Central, East)

- Simulation A: Single Project Comparison
  - 10,700,000 cuyds, 1794 acres
  - Same environmental forcing Y_0 - Y_{50}
  - Grain size: NS@156µm and OCS@160µm
  - Distance: NS@1-8.5miles, OCS @ 4-34 miles
  - Slop Factors: NS@1.2-1.6 and OCS @1.01-1.1
  - NPV and BE based comparisons of economic performance

Generic Trade-Offs

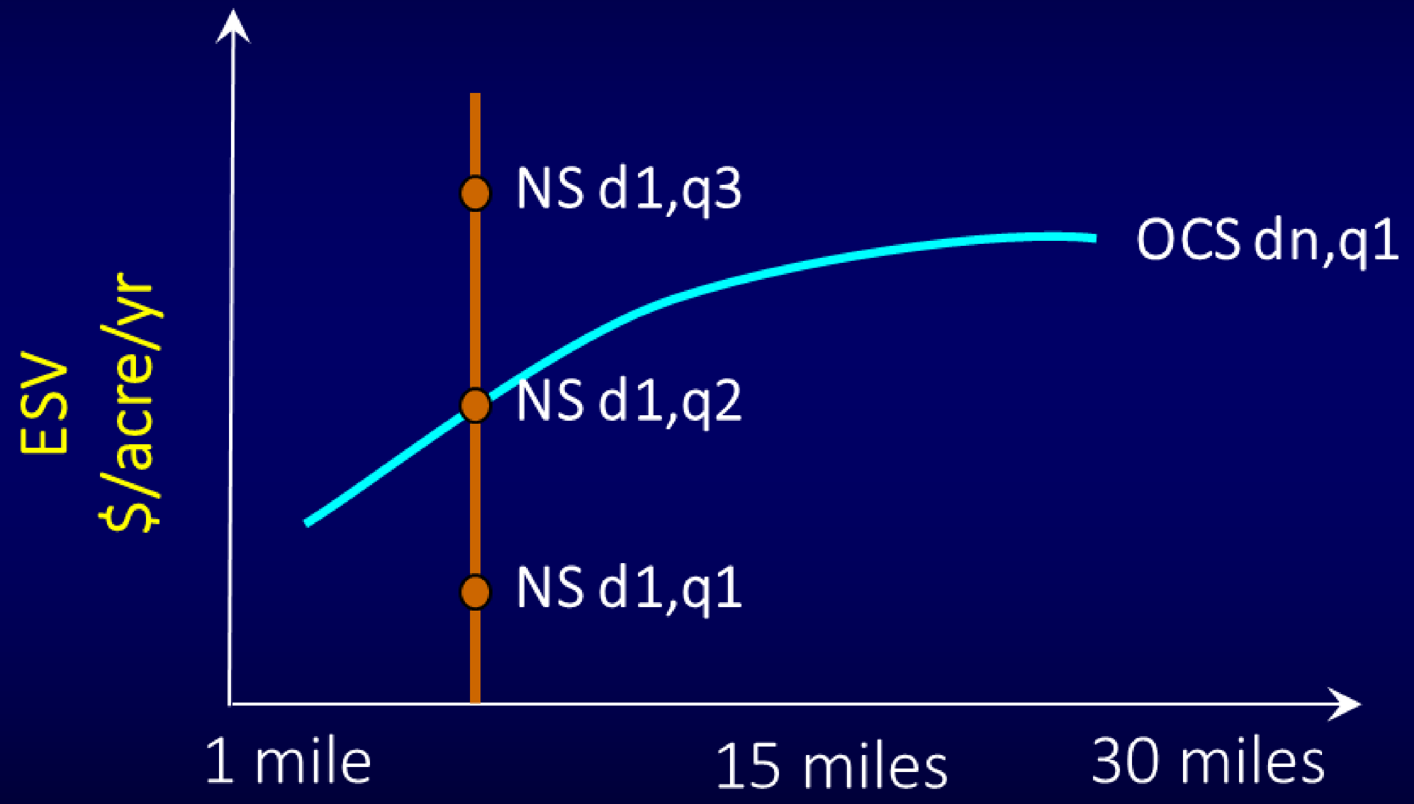
Required ESV($) for B:C=1.0



Generic Trade-Offs

Required ESV($) for B:C=1.0

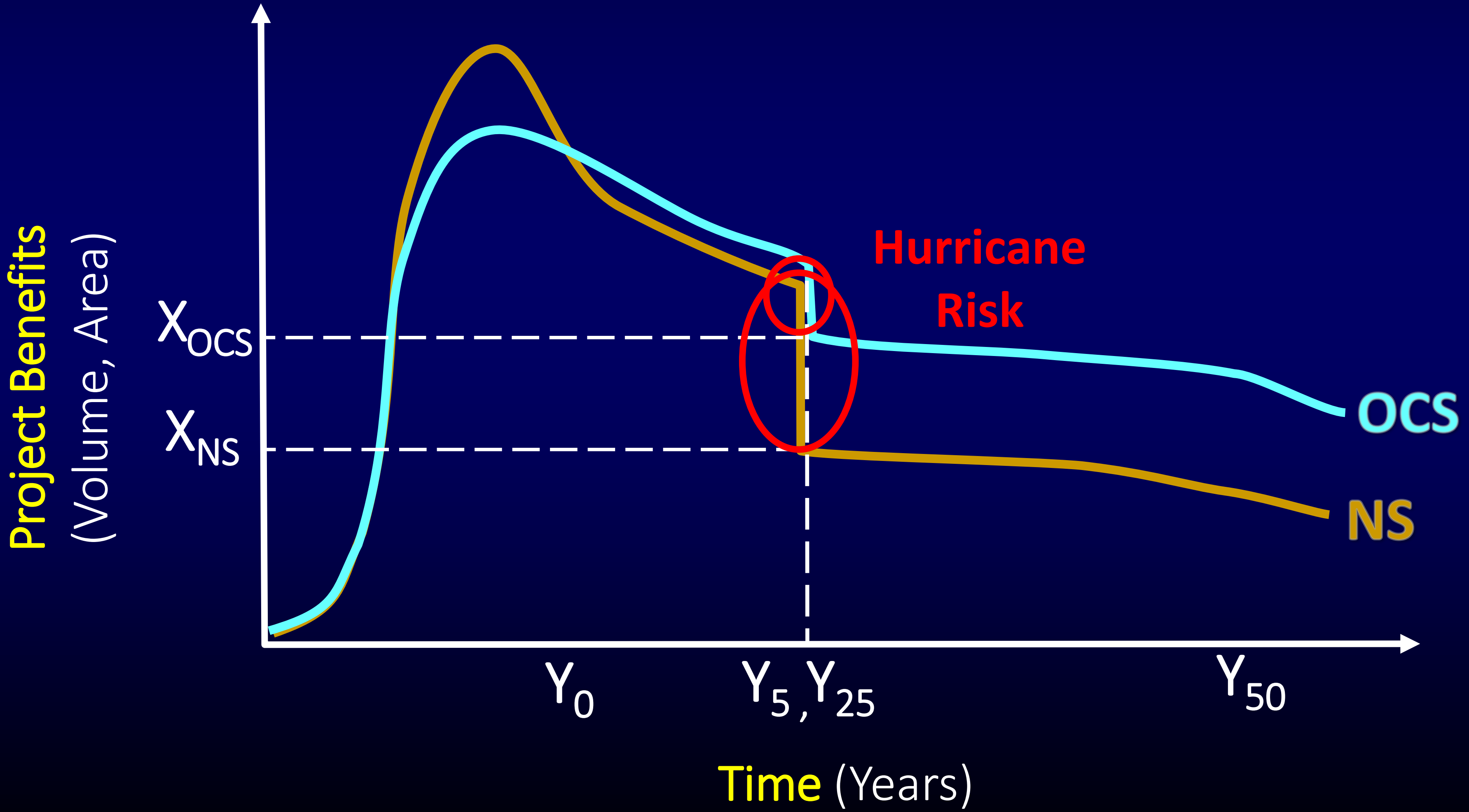
Distance, Quantity



Preliminary Observations

- Traditional cost comparisons depict OCS projects as more expensive, approximately 2x that of NS, *but*…
- Such comparisons are usually limited to the subaerial template and fail to capture subaqueous contours, *also…*
- Geophysical modeling shows that OCS and NS trajectories diverge over time, with higher resilience for OCS materials, *however*…
- The time required for these differences to fully manifest (under typical forcing) is a constraint, given that simulated project life is only 50 years, *but consider…*

Nearshore (NS) vs. OCS Sediments



Preliminary Observations

- Trajectory divergence is expected to be more pronounced in the wake of large-scale storm impacts, with greater economic implications more likely for earlier occurring storms, *yet*…

- For NS projects, the majority of economic variation is driven by pre-project materials losses (i.e. handling, fines, and settling), *so*…

- There is a clear trade-off between *quantity* and *distance* for NS- and OCS-sourced projects, *where*..

- Small to average "slop factors" appear to quickly negate NS cost advantages over OCS-source projects with transport distances of 15 miles or more.

Next Steps…

In-Progress:

Simulation Type B: Hurricane Impact Scenario

Major storm impact to estimate the resiliency and economic effects at different points in time (Y_5, Y_{20}).

Potential:

Simulation Type C: Periodic re-nourishment

More frequent nourishment via smaller dredge(s). Requires understanding of various dredge capacities and operating costs.

Simulation Type D: Sand Engine

Less structured approach in which a large amount of sediment is strategically deposited and redistribution via natural processes within the littoral zone.

Thank You