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

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M15AC00013: Background and Rationale

- **Trend:** Demand for dedicated dredging has doubled in the past decade and ~ 90 million yd^3 of sediment will be needed in LA over next 50 years.

- **Sediment sources:** Acquisition for projects is typically restricted to:
  - Nearshore (NS) materials of limited quantity and quality
  - Outer Continental Shelf (OCS) inputs of potentially higher quality and costs

- **Trade-offs:** economics of NS vs. OCS have yet to be systematically analyzed, but are expected to be project-and location specific, and influenced by a wide range of constraints related to geomorphic characteristics, technological limitations, seasonal risks, and environmental policy.

- **Goal:** This project characterizes those constraints and integrates them into a geophysical-economic framework for estimating the costs incurred, and ecosystem services derived, from projects relying on these two source materials.

Economic Model and Project Framework

- Data sources and averages
- Preliminary cost models
- Coupled model approaches

Data for Economic Model

Data on costs and benefits:

- 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.

Primary data source:

- Project bids for restorations projects
  (LaCPRA "Bid-Tab" Compilations 1994-2016)

Projects for analysis (Barrier Islands and Shorelines)

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

Projects by Agency

Table 1. Coastal Restoration and Selected Dredging Projects 1997-2015

Programs	Bids	%	**$/CuYd** (2016)	**Distance**	$/Acre	Cuyd/Acre
CWPPRA	43	61	8.28	4.07	73,735	10,149
NRDA	13	18	12.04	11.15	102,059	8,709
CIAP	7	10	17.62	19.43	176,673	9,010
NFWF	4	5	26.40	34.5	291,300	11,034
STATE	2	3	21.79	20.75	190,207	8,727
BERM	2	3	20.51	17	125,473	6,119
Total	71	100	-	-	-	-

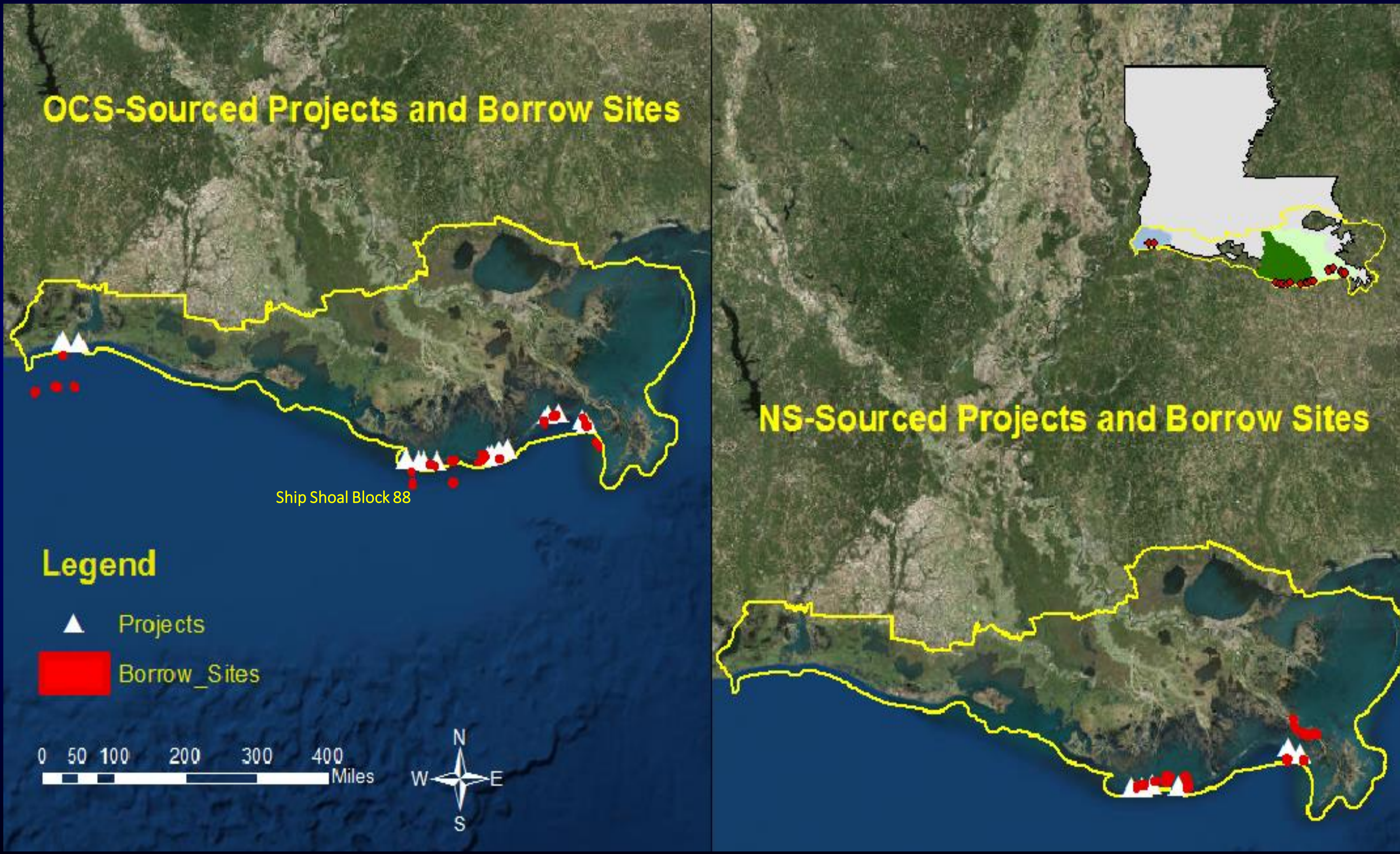
(1) Coastal Impact Assistance Program (CWPPRA); (2) National Resource Damage Assessment (NRDA); (3) Coastal Impact Assistance Program (CIAP); (4) National Fish and Wildlife Foundation (NFWF); (5) State Only Projects (STATE); (6) Berm to Barrier

OCS- and Nearshore- Sourced Projects

Table 2. Outer Continental Shelf Sourced (OCS-Sourced) and Nearshore Sourced (NS-Sourced) Projects Distribution 1997-2015

Dredging Material Source	OCS-Sourced	NS-Sourced	Total
CWPPRA	21	22	43
NRDA	5	8	13
CIAP	7	0	7
NFWF	4	0	4
STATE	2	0	2
BERM	0	2	2
Total	39 (55%)	32 (45%)	71

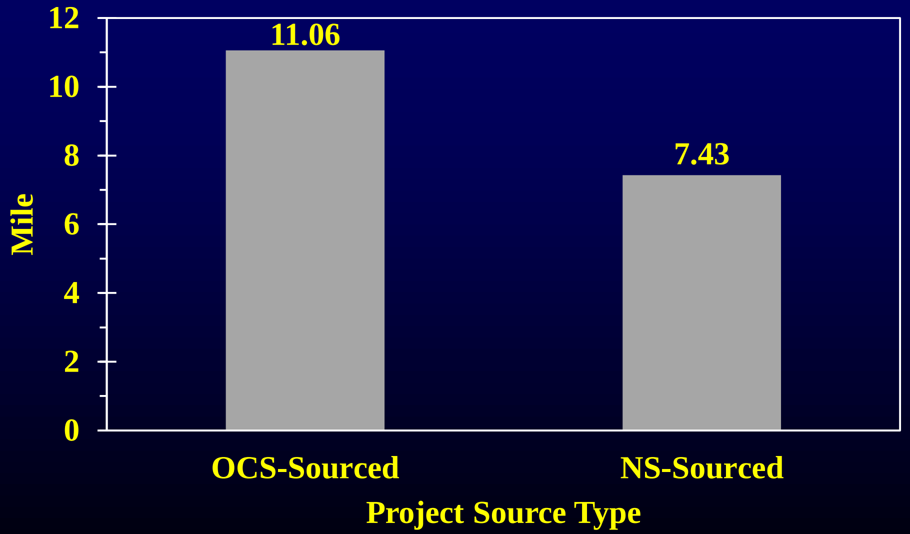
Borrow Sites Location and Projects

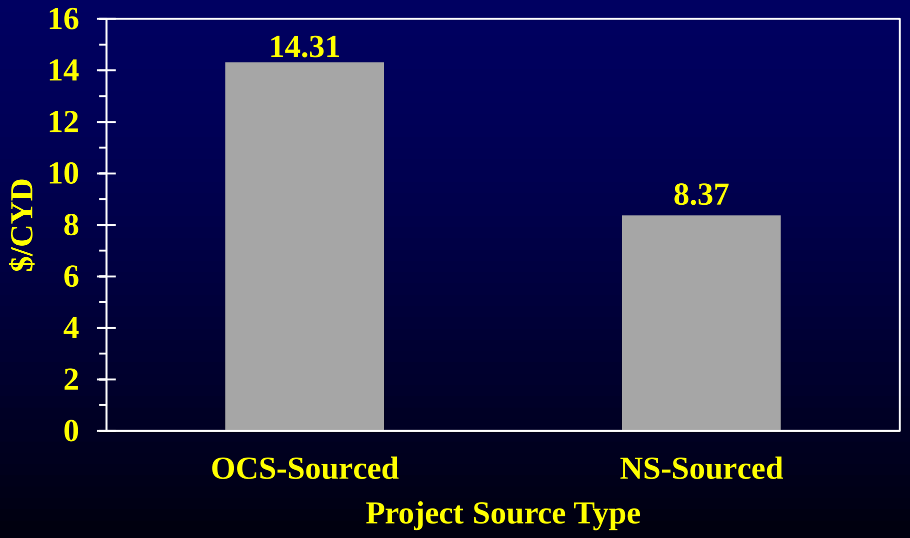


Cost by Distance and Volume

Table 3. Average Dredging Distance and Cost per Cubic Yard for OCS and NS - Sourced Projects 1997-2015

Source Type	Obs.	Distance (Miles)	Min.	Max.	$/cuyd (2016)	Min.	Max.
OCS-Sourced	39	11.06	2	34.5	$14.31	6.39	28.80
NS-Sourced	32	7.43	1	22	$8.37	3.29	25.44

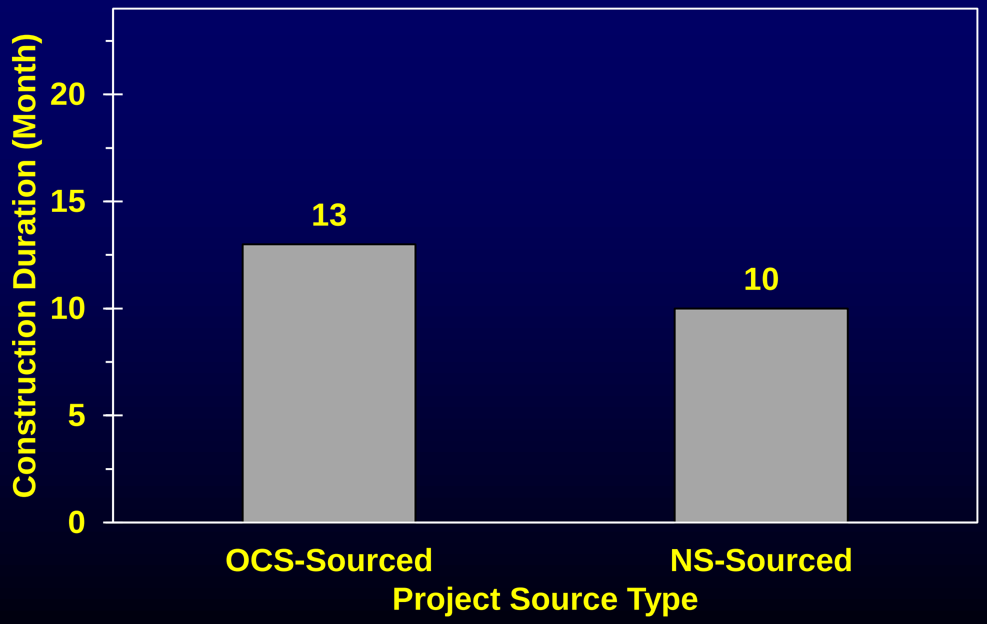




Average Construction Duration

Table 6 Average Construction Duration for OCS and NS -Sourced Projects 1997-2015

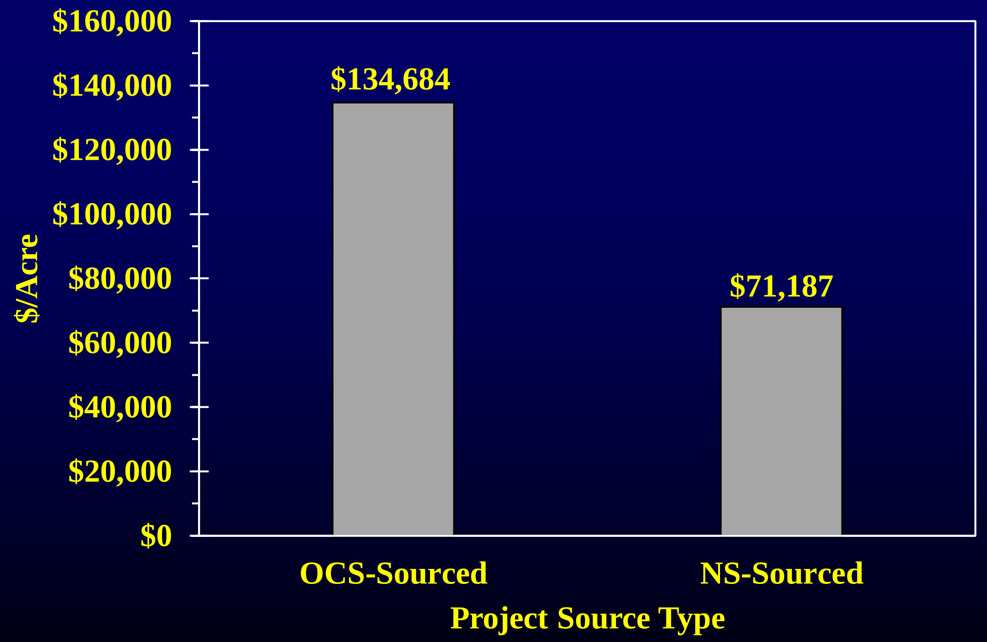
Source Type	Obs.	Duration (Months)	Min.	Max.
OCS-Sourced	39	13	6	20
NS-Sourced	32	10	5	17



Costs by Area

Table 4. Avg. Cost per Acre for OCS and NS -Sourced Projects 1997-2015

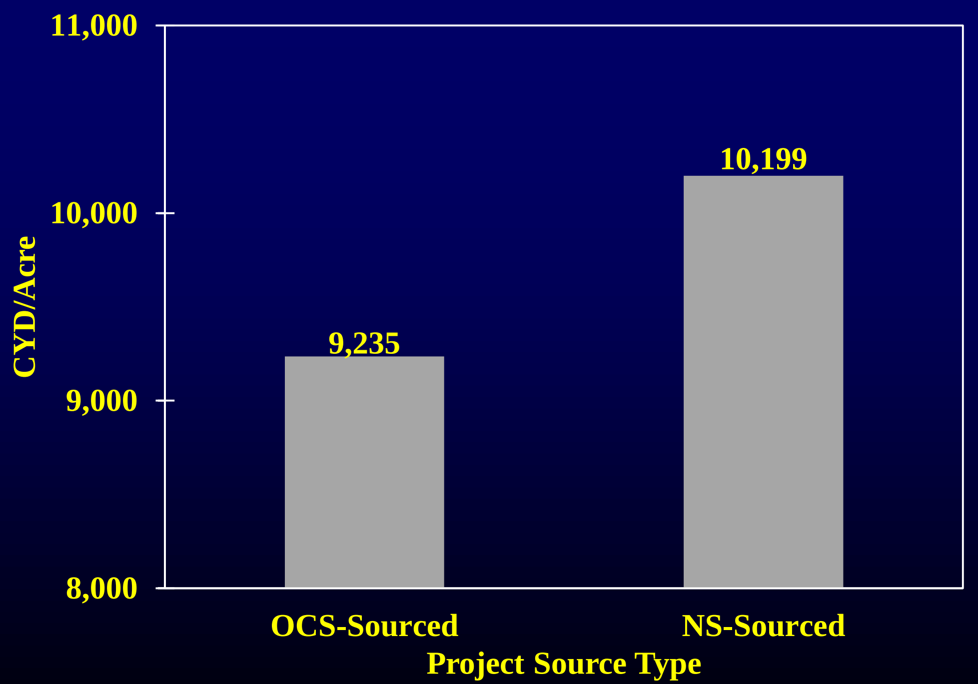
Source Type	Obs.	$/Acre	Min.	Max.
OCS-Sourced	39	$134,684	42,890	317,812
NS-Sourced	32	$71,187	29,199	161,682



Volume by Area

Table 5. Avg. Cuyd/Acre for OCS and NS -Sourced Projects 1997-2015

Source Type	Obs.	Cuyd/Acre	Min.	Max.
OCS-Sourced	39	9,235	3,475	16,246
NS-Sourced	32	10,199	6,119	14,888



What drives the costs of dredging projects?

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
ADE	Average Dune Elevation (feet)	6.39	1.20
ETS	Endangered and Threatened Species (Yes=1, Otherwise=0)	0.46	0.50
CWPPRA	Coastal Program (CWPPRA=1, Otherwise=0)	0.61	0.49
WEEKS	Bidder (WEEKS=1, Otherwise=0)	0.38	0.49
BP	Booster Pump (Yes=1, Otherwise=0)	1	0
PYT	Payment Type (Fill=1, Cut=0)	0.61	0.49
CUTTER	Dredge Equipment (Cutterhead=1, Otherwise=0)	0.86	0.35
RH	Re-handing (Yes=1; Otherwise=0)	0.27	0.45
OFFSHORE	Project Borrow Source Location (OCS=1, NS=0)	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

Cost Model Results

Construction Cost for <u>OCS</u> Projects

N=39 R-square = 0.91

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	-1.30e+07	4122457	-3.16	0.00
CYD	7.19	1.16	6.20	0.00
MOB	3.12	0.87	3.58	0.00
DIST	1712287	215741	7.94	0.00

Construction Cost for <u>NS</u> Projects

N=32 R-square = 0.96

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	-1.40e+07	4987497	-2.81	0.01
CYD	6.16	1.29	4.76	0.00
MOB	1.99	0.73	2.72	0.01
DIST	1653004	399602	4.14	0.00

Coupled Model Approaches

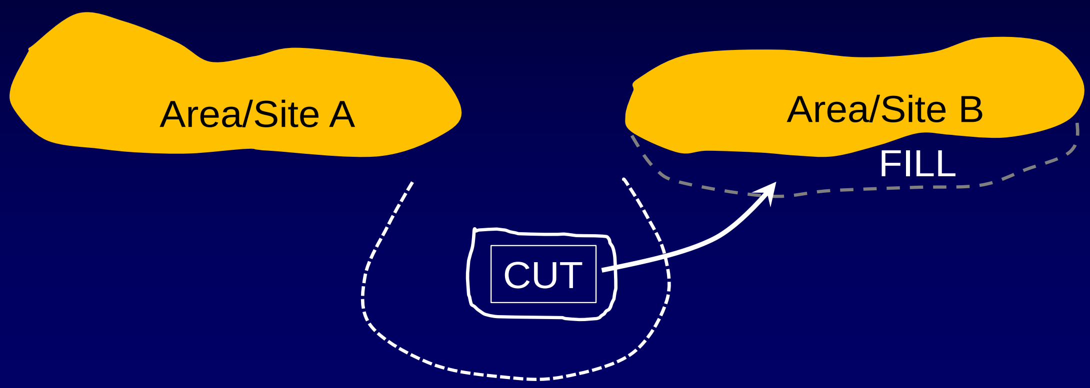
Simulation Type A. Single Project Comparisons with NS vs. OCS

- Common Starting Points
  - Same target area (Q_X in y1), time horizons (Y=n), environmental forcing
- Cost Models (NS, OCS)
  - Function of sediment quantity, mob/demob, distance
- Benefit Models (NS, OCS)
  - Geophysical dynamics driven by sediment quality
  - Volume & acreage trajectories at t = 0, 1, 2, 3, ….50y
  - Direct + Indirect benefits (*up-drift* and *down-drift* effects)

Scenario 1 – NS sediment excavated from within the system

Indirect benefits at t=0,1,2..n)
(Down-drift barrier)

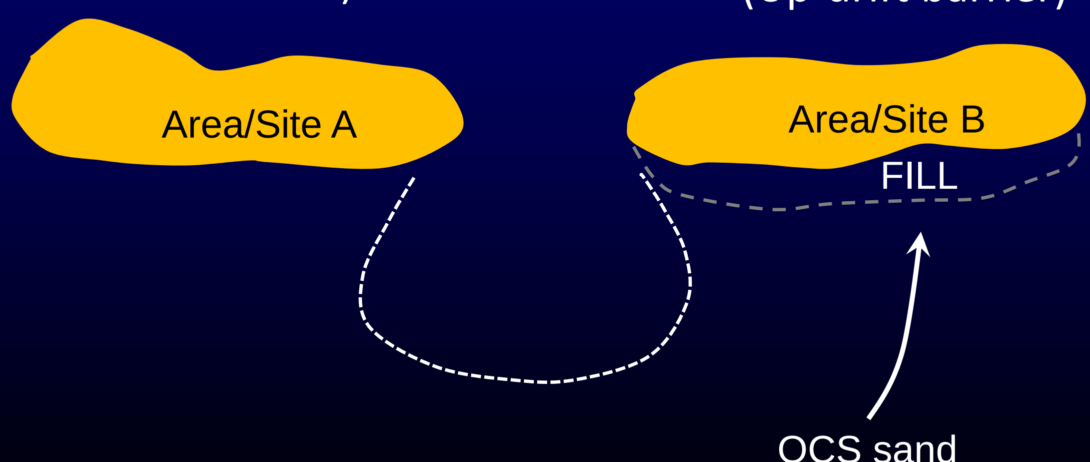
Direct benefits at t=0,1,2..n)
(Up-drift barrier)



Scenario 2 – OCS sand from outside the system

Indirect benefits at t=0,1,2..n)
(Down-drift barrier)

Direct benefits at t=0,1,2..n)
(Up-drift barrier)



Traditional approach to project comparison

(Costs Efficacy)

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

Ecosystem Services =  +  + 

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 benefit in time *t* in $

C_t is cost in time *t* in $

R is the discount rate

t is the year (T=1-20y, 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 specified for different scenarios.

Benefit-Cost Analysis

$$\text{BC Ratio} = \sum_{t=1}^{T} \frac{B_t}{(1+R)^t} \Big/ \sum \frac{C_t}{(1+R)^t} \quad = 0$$

Where:

B_t is benefit in time t in $

C_t is cost in time t in $

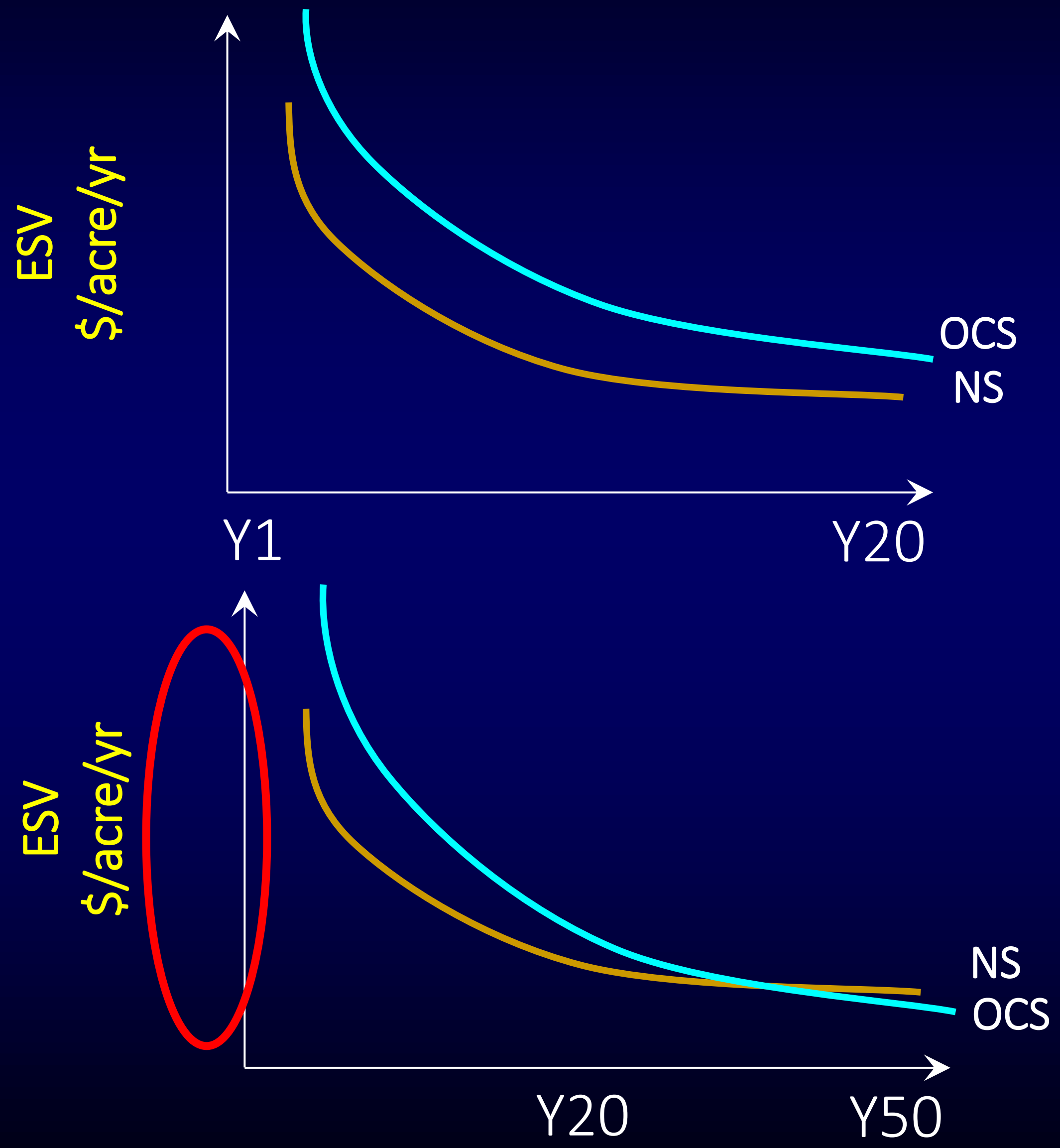
R is the discount rate

t is the year (T=1-20y, 1-50y)

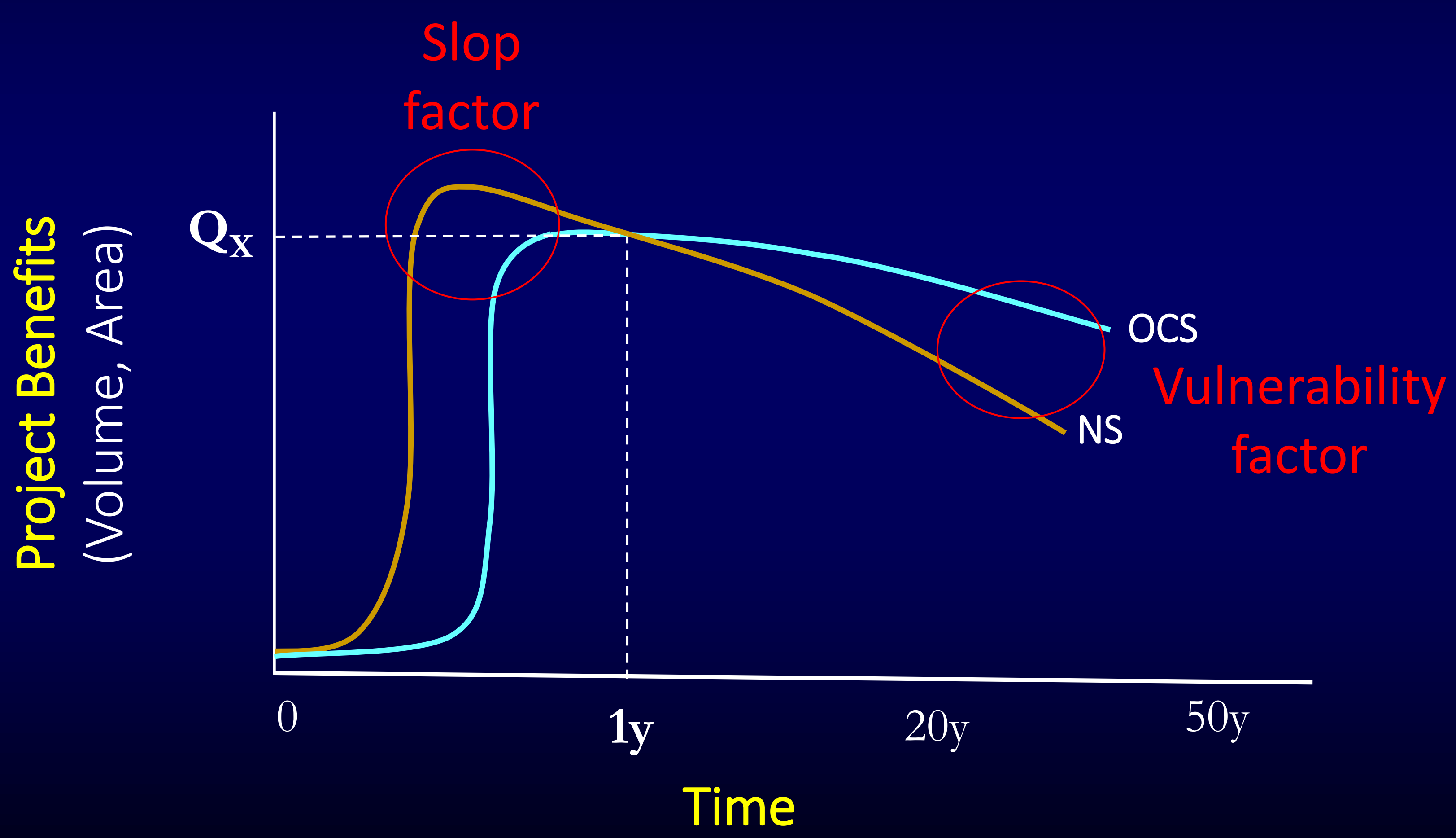
Since we know costs ($) and physical quantities (x) at time t, we can set B:C=0 and solve for the ESV ($) required to break-even under different scenarios.

Conceptual Break-Even Simulations

Required ESV($) for B:C=1.0



Economic findings will be primarily influenced by material quality dynamics



Next Steps…

Simulation Type A: Single Project Comparisons

Ongoing refinements to sub models and coupled model, series of NPV and BC-based comparisons under wide range of simulations (Fall 2017)

Simulation Type B: Frequent Renourishment

Assume more frequent delivery of sediment via smaller dredge(s). Requires understanding of various dredge capacities and operating costs. Relies on cost templates used USACE and Texas A&M University (Spring-Summer 2018)

Simulation Type C: Sand Engine

Less structured approach in which a large amount of sediment is strategically deposited and redistributed via natural processes within the littoral zone. Project template would be less defined by surface area of subaerial land and more about the volume of sediment within the project area or region (Spring-Summer 2018)

Thank you

Cost Model Results

Construction Cost for Both OCS/NS Projects

N=71
R-square = 0.89

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	-1.41e+07	3312863	-4.27	0.00
CYD	6.80	0.87	7.79	0.00
MOB	2.44	0.54	4.51	0.00
DIST	1838315	190776	9.64	0.00