CONNECTIONS WITH THE NEARSHORE OCEAN AT THE MOUTH OF THE COLUMBIA RIVER (it's all about the sand)

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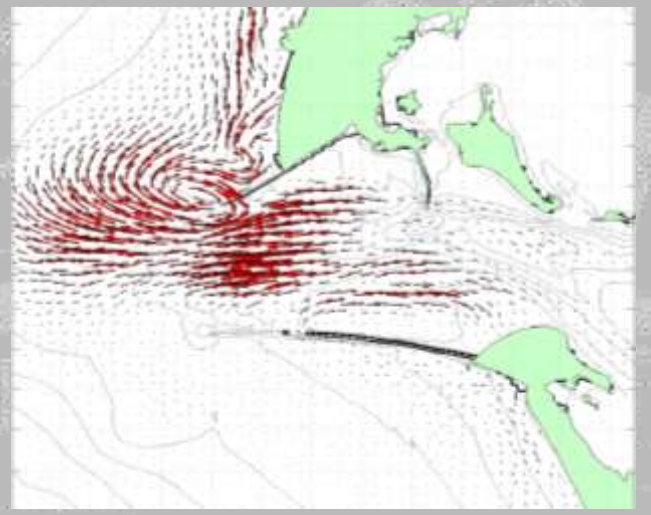
Columbia River Estuary Conference: Reconnection
16-18 May 2023
Day 1 - 1530 presentation



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OUTLINE

Navigation Infrastructure at Mouth of Columbia River – A Legacy of Inlet Stabilization

Working with Nature at a confluence of Ocean & River to sustain maritime commerce = Our Work is Never Done.

Evolving Morphology Conditions along Ocean Side of the MCR

Resilience Strategy #1---Understand the forcing environment

Resilience Strategy #2---Use dredged material to sustain sediment budget & morphology

Resilience Strategy #3---Do no harm to ecology & stakeholder use of the area = Do good Science & COLLABORATE !

Navigation & Ecology within the MCR and LCRE is linked to Sustaining Morphology

Evolving Conditions within the Lower Estuary - Affects on the MCR & Vice-Versa

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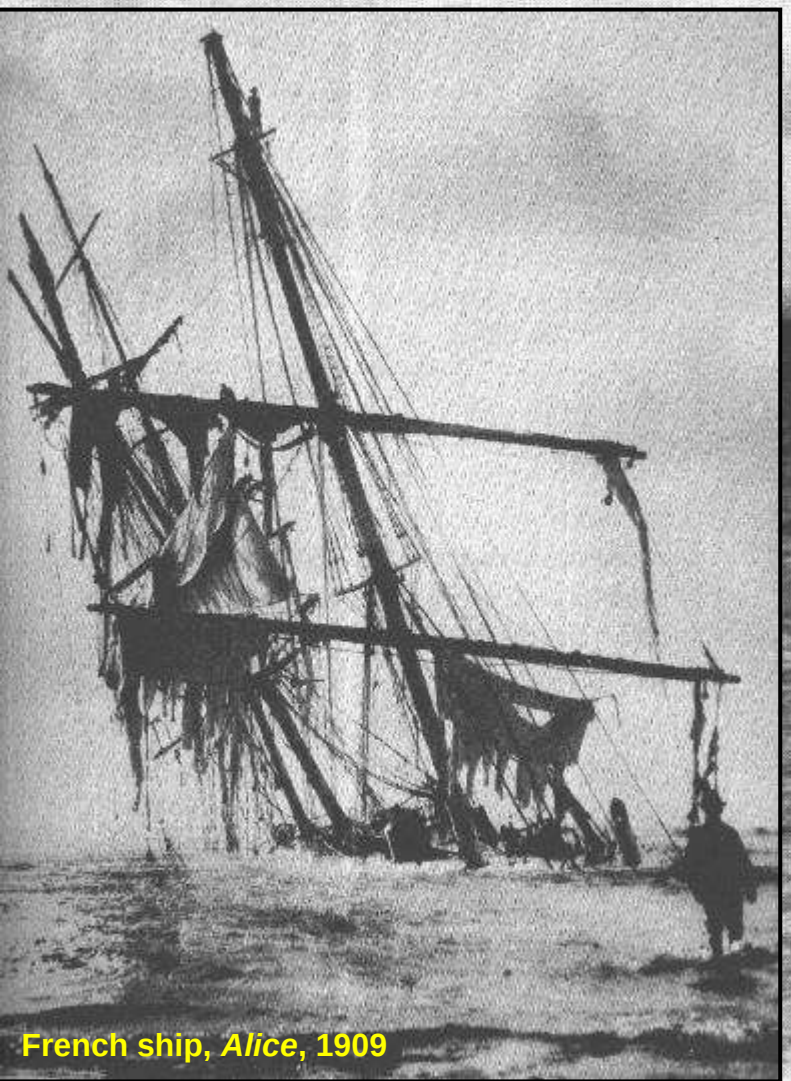
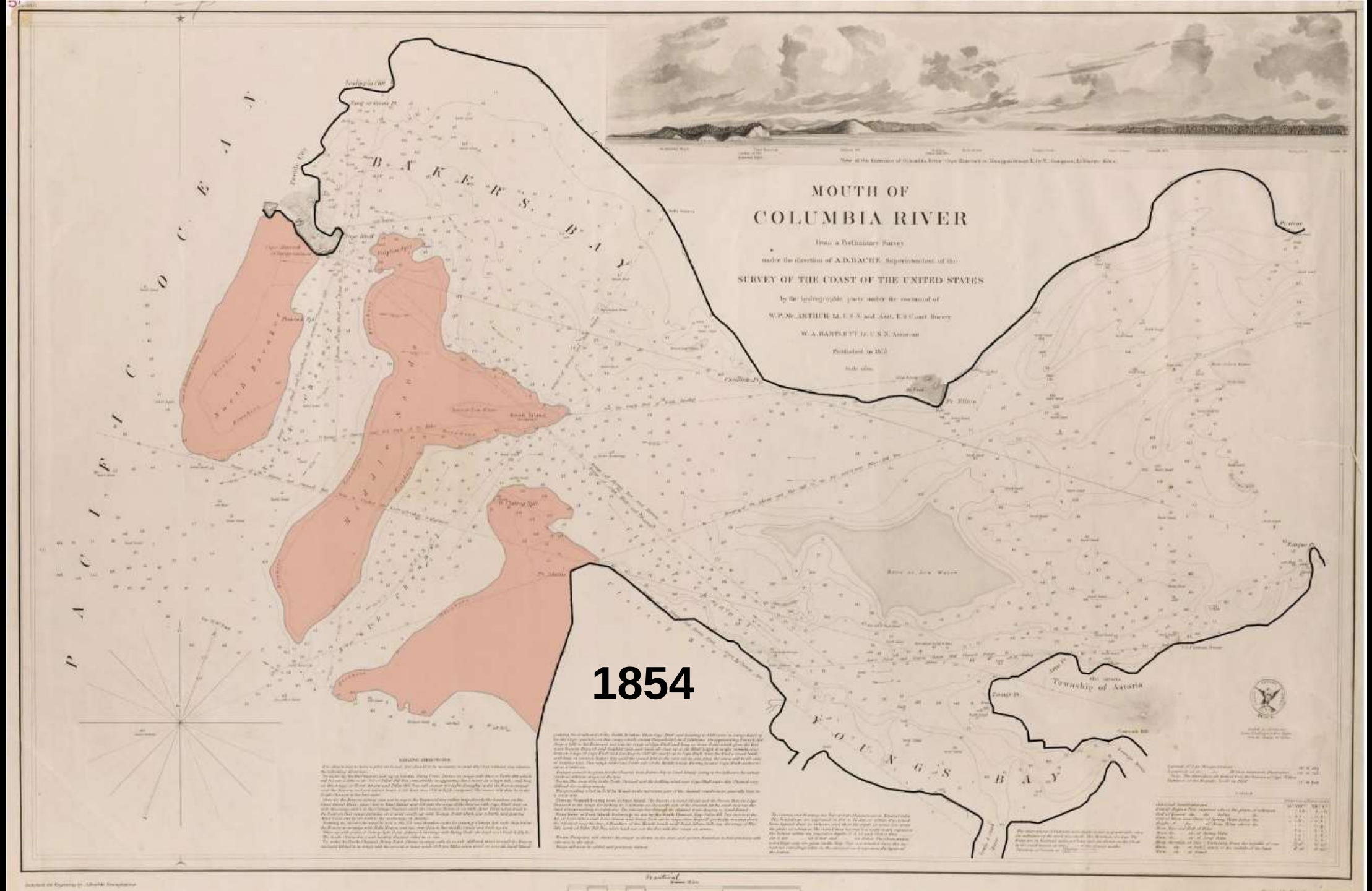
Before the MCR was improved for navigation during 1885-1939,
it was one of the most dangerous bar crossings in the world--- Graveyard of the Pacific.



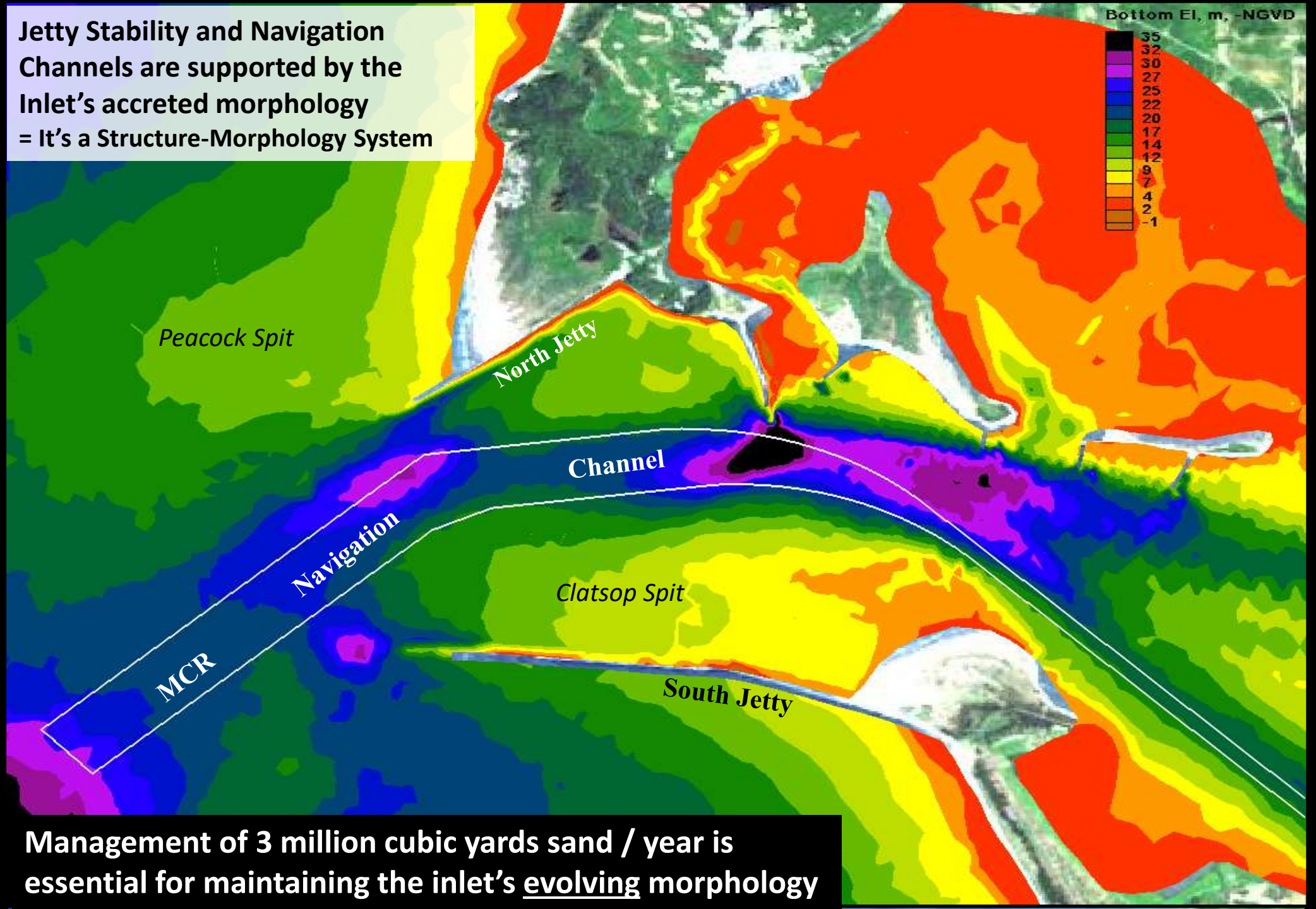
French ship, *Alice*, 1909

”….the terrors of the bar of the Columbia are one of the most fearful sights that can possibly meet the eye of the sailor”

French bark, 1900’s
Colonel de Villebois Mareuil


MOUTH OF
COLUMBIA RIVER
From a Preliminary Survey
under the direction of A.D.BACHE, Superintendent of the
SURVEY OF THE COAST OF THE UNITED STATES
by the hydrographic party under the command of
W.P.Mc.ARTHUR Lt. U.S.N. and Asst. U.S.Coast Survey
W.A.HARTLETT Lt. U.S.N. Assistant
Published in 1854
PACIFIC OCEAN
BAKERS BAY
Township of Astoria
1854

Jetty Stability and Navigation Channels are supported by the Inlet's accreted morphology
= It's a Structure-Morphology System



Management of 3 million cubic yards sand / year is essential for maintaining the inlet's evolving morphology

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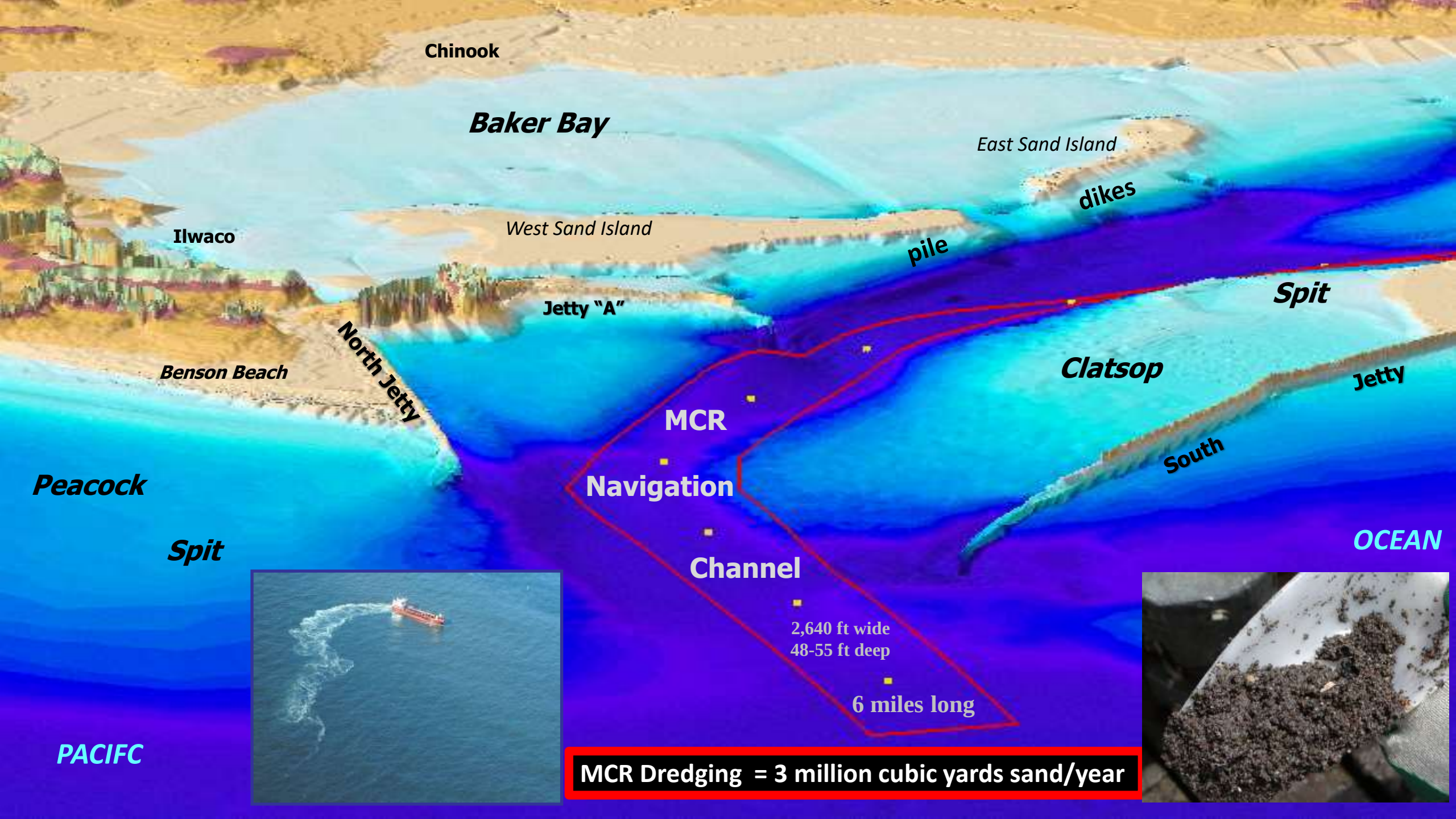
Chinook
Baker Bay
East Sand Island
dikes
pile
West Sand Island
Ilwaco
Jetty "A"
Spit
North Jetty
Benson Beach
Clatsop
Jetty
South
MCR
Navigation
Channel
2,640 ft wide
48-55 ft deep
6 miles long
Peacock
Spit
OCEAN
PACIFC
MCR Dredging = 3 million cubic yards sand/year

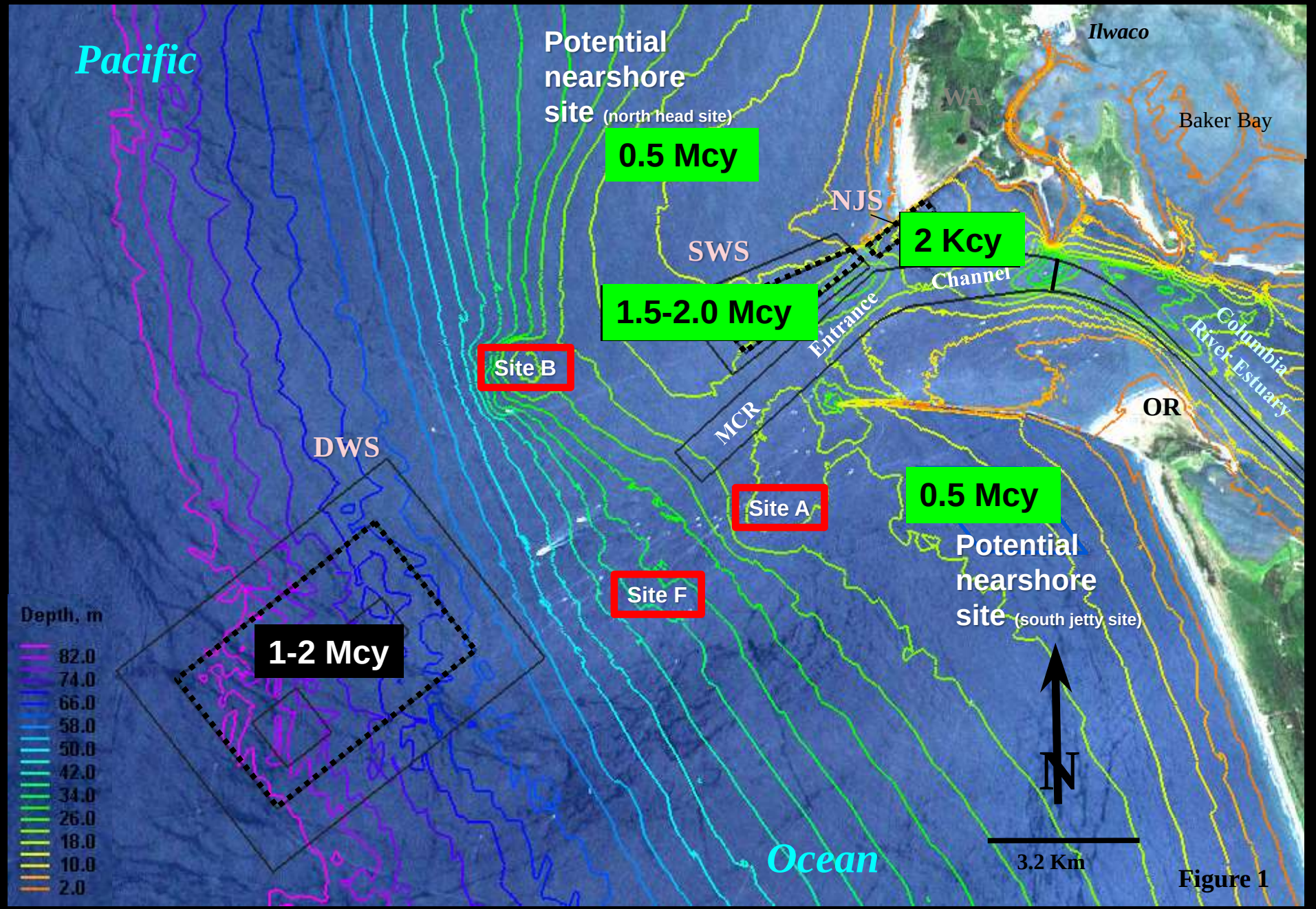

Figure 1

DWS= Deep Water Site, 102 MPRSA SWS= Shallow Water Site, 102 MPRSA NJ Site = North Jetty disposal site, 404 CWA

Mouth of the Columbia River Bathymetry and Progression of Dredged Material Placement Sites

During 1997-2006, USACE realized the imperative to Maximize nearshore placement of MCR dredged sand----

New Objective: Obtain New nearshore placement sites.

Problem: We did not have the science to convince S&As / stakeholders that:

1) We could use NS sites w/o harming ecology.
2) Sand placed in NS sites would benefit shore morph.

DO ACTIONABLE SCIENCE - Collaborate to develop scope, assess results, and adapt approach

> Use a Trusted Facilitator to Lead Meetings & Oversee Work-Flow

CONTRIBUTORS

Columbia River Crab Fisherman Association
Lower Columbia River Solutions Group
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USGS
NOAA
USEPA
USACE-ERDC
USACE-NWP
Golder Associates
Pacific & Clatsop County
WDFW
ODLCD
WDOE
OSU & PSU

ESSENTIAL DATA

*Observed Bathymetry Change
Observed Waves, Currents, Suspended Sediment, WQ
*Bonafide Sediment Tracer Studies (observed results)

*Benthic & Epibenthic Sampling / Insitu Observations

Wave Models
Hydrodynamic Models (3D / 2D)
*Sediment Transport Models
Plume-Fate Models

Sustained Collaboration = Earn the Trust between stakeholders, project proponents, and researchers

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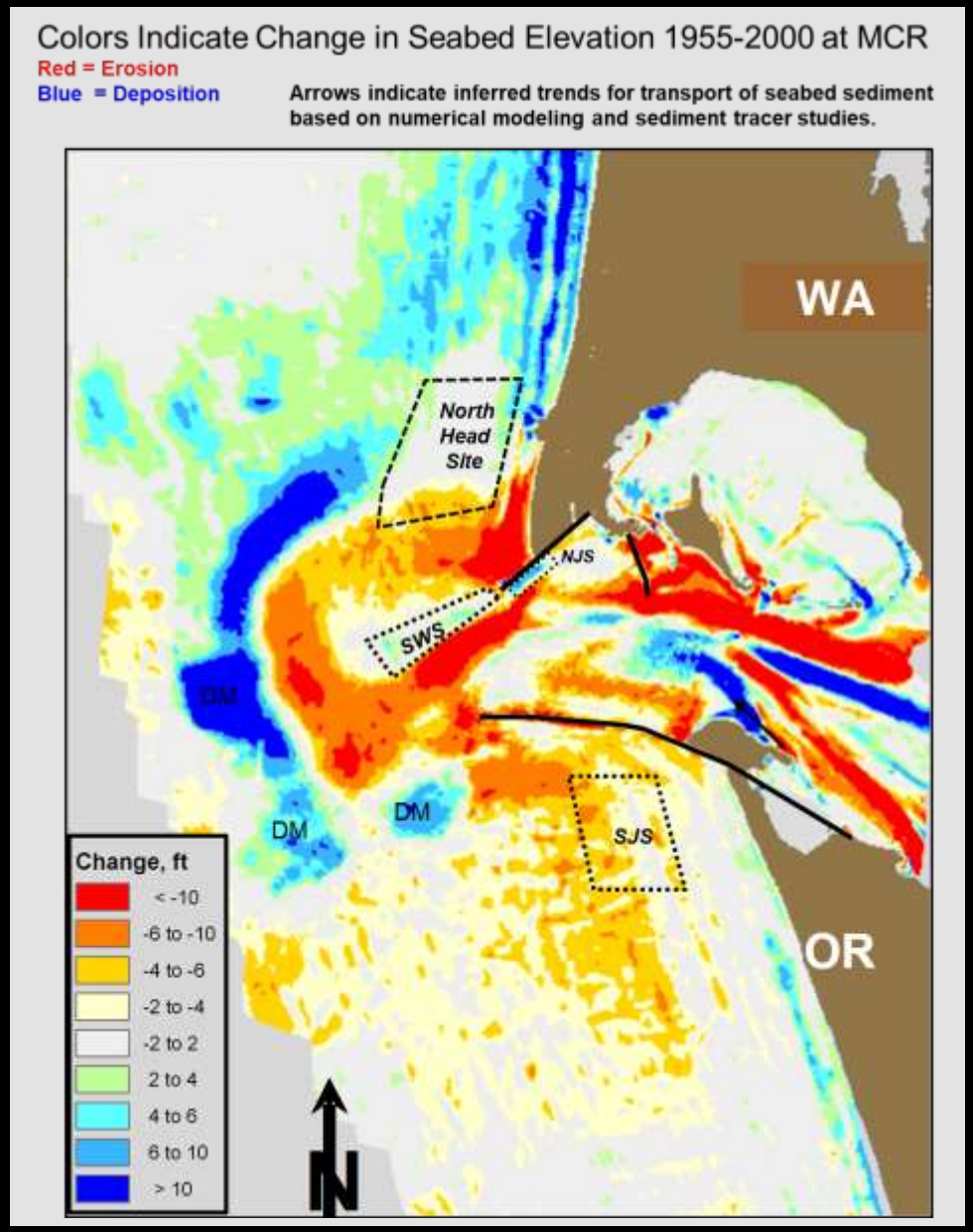
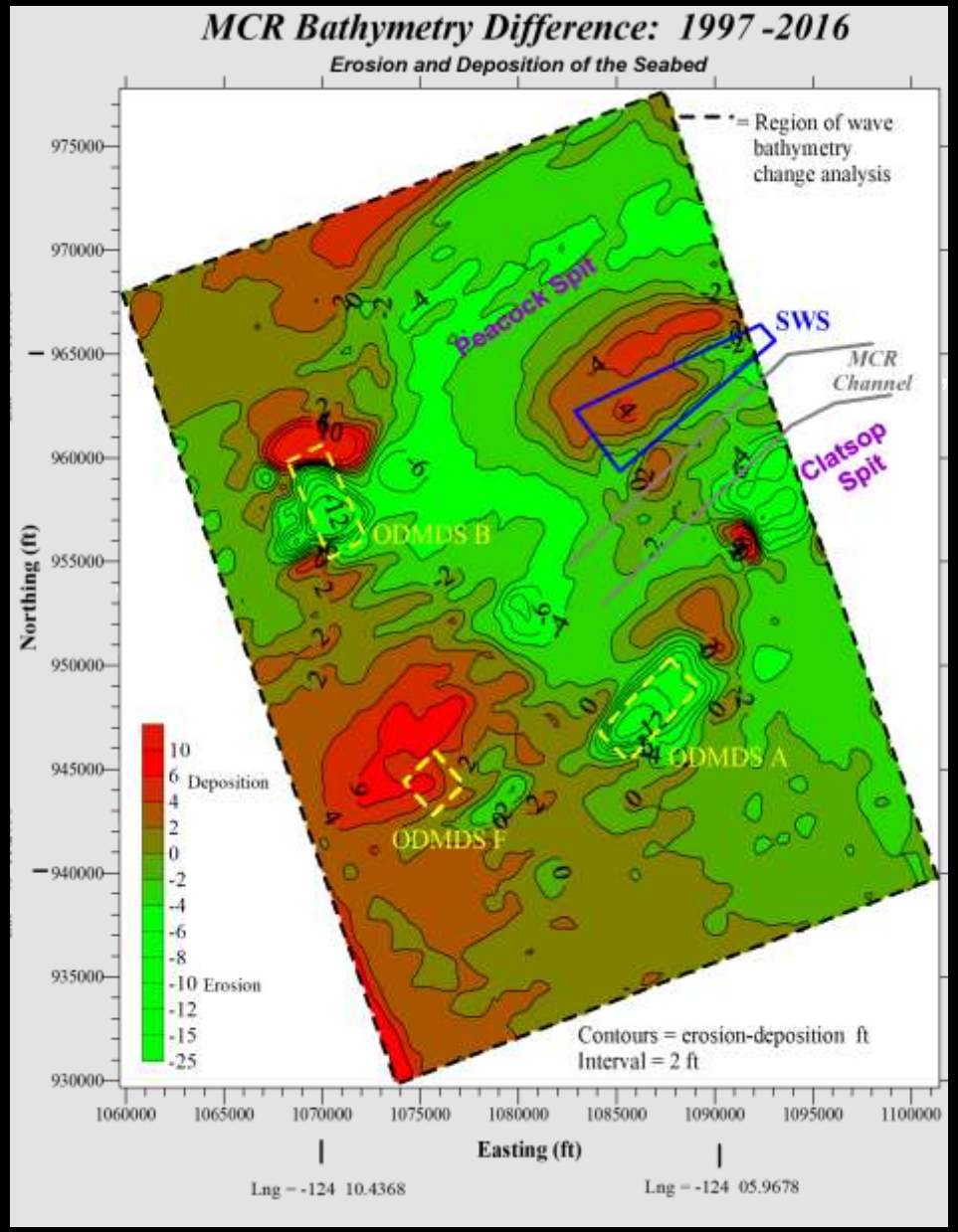
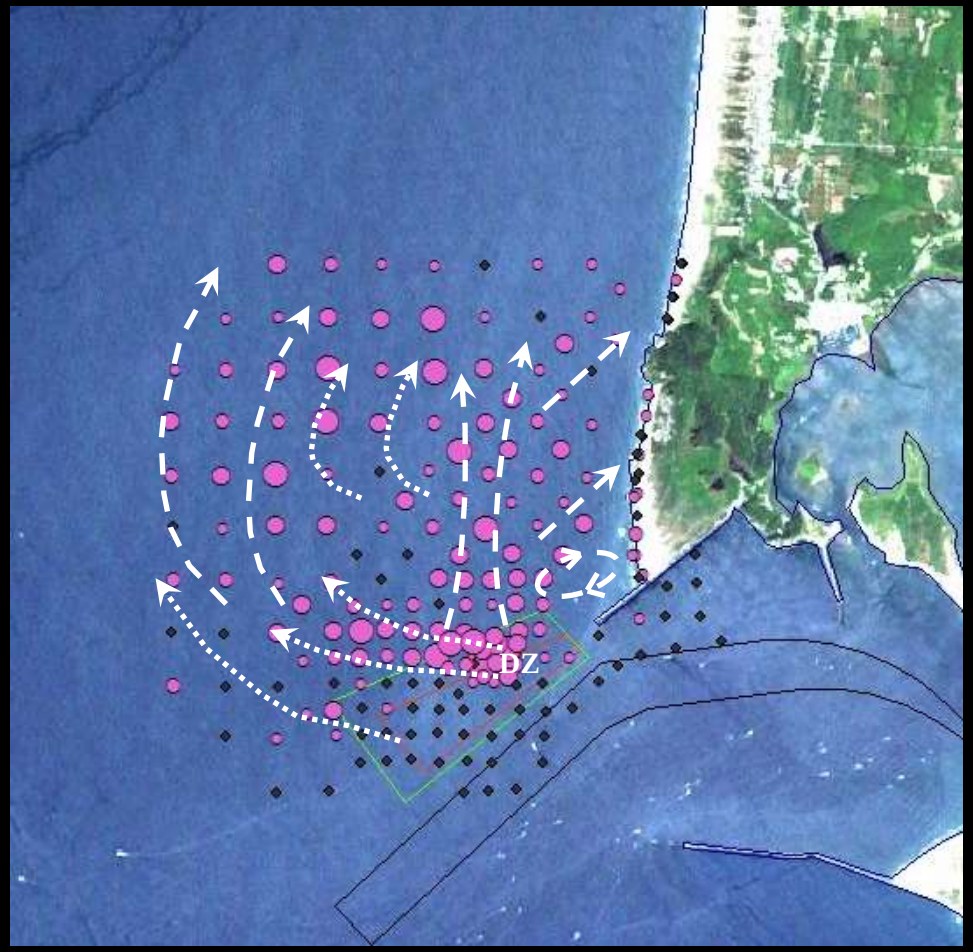
Analysis of Observed Bathymetry Change is a Reliable Method for Identifying Sediment Transport Trends



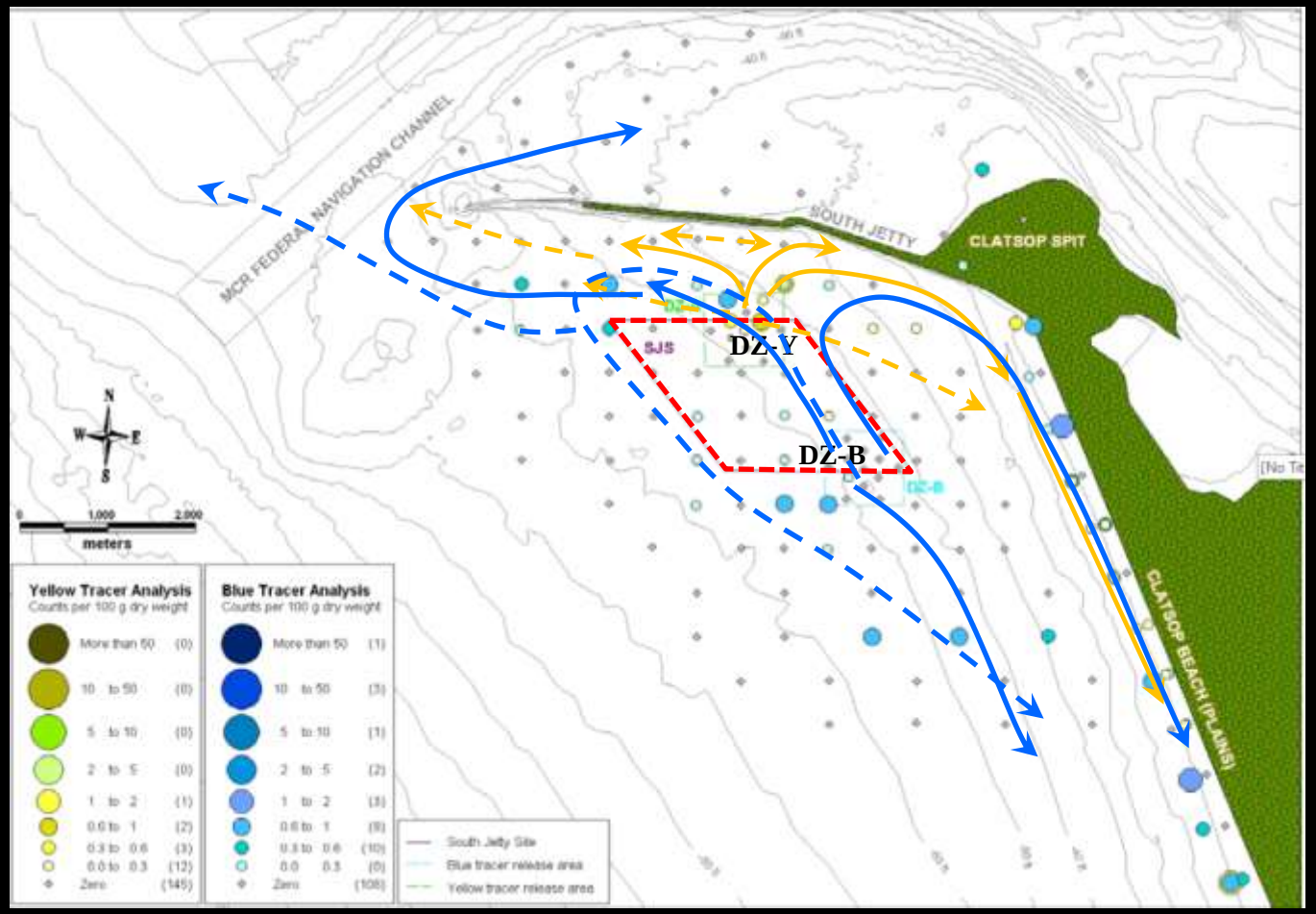


Sediment Tracer Studies at Dredged Material Placement Sites NORTH and SOUTH side of the MCR Inlet,
Useful for observing sediment transport pathways

6 months after Deployment
April 2007
NORTH SIDE
Red Tracer released at DZ



51 months after Deployment
3 September 2009
SOUTH SIDE
YELLOW Tracer released at DZ
BLUE Tracer released at DZ



CamPod imagery demonstrated that USACE could apply "thin-layer" placement methods and avoid impacts to benthic ecology at placement sites

Frame 5 of 5
After passage of Hopper dredge

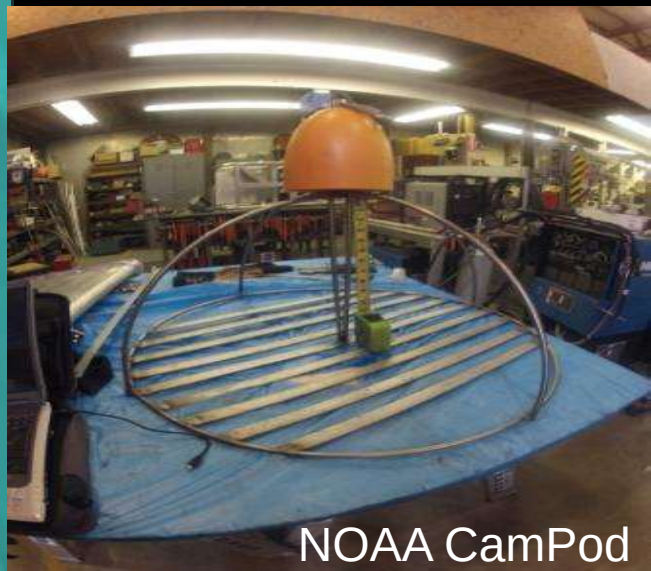
Post Placement
1.5 minutes after frame 1

Crabs returned several minutes later

Crab bait

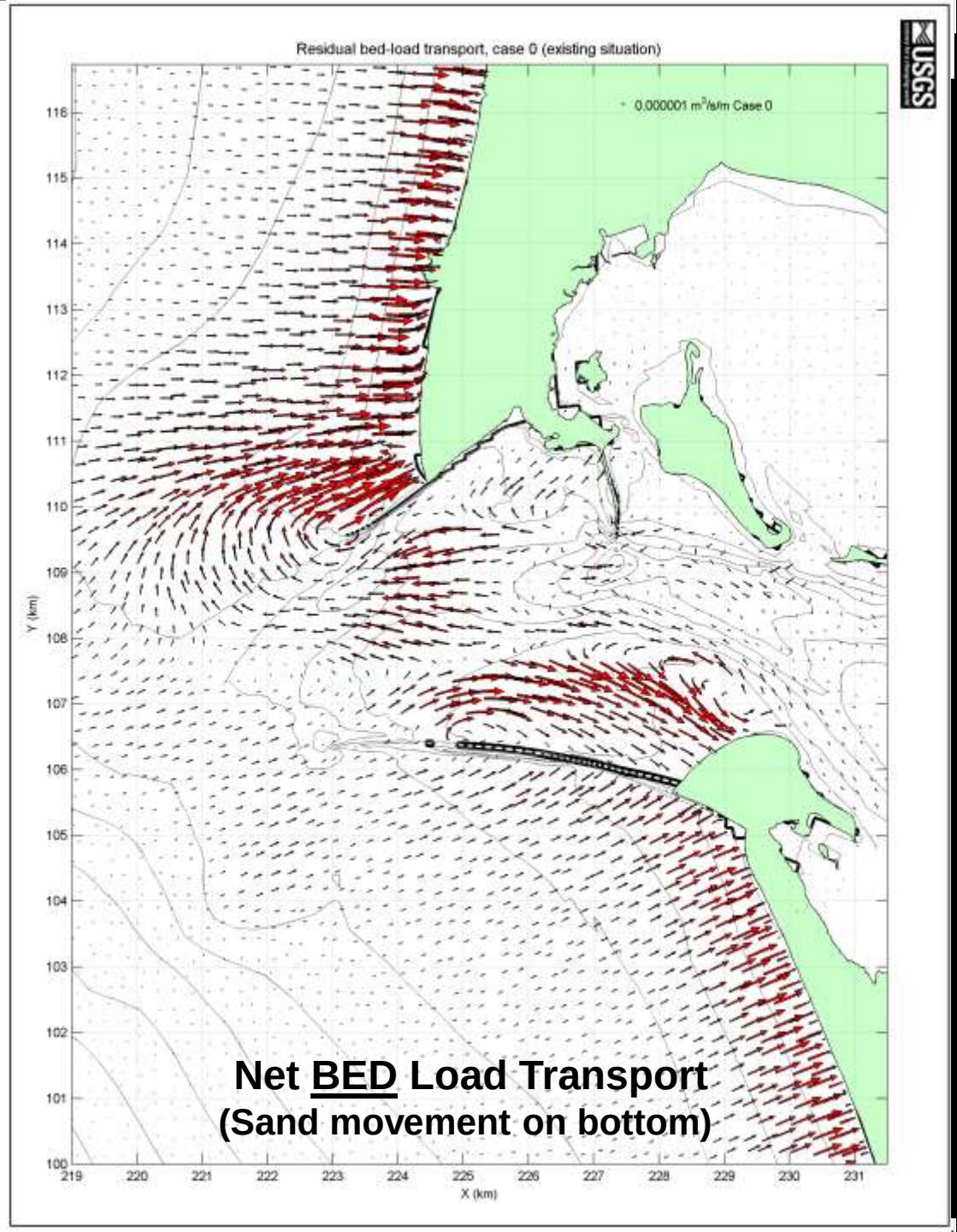
2 inches (5 cm)

USACE Hopper Dredge 5,000 cy/load dredged material released **through 12 bottom doors**



Deposited dredged material (sand) = ~ 1 inch (2.54 cm)

NOAA CamPod



Net BED Load Transport
(Sand movement on bottom)

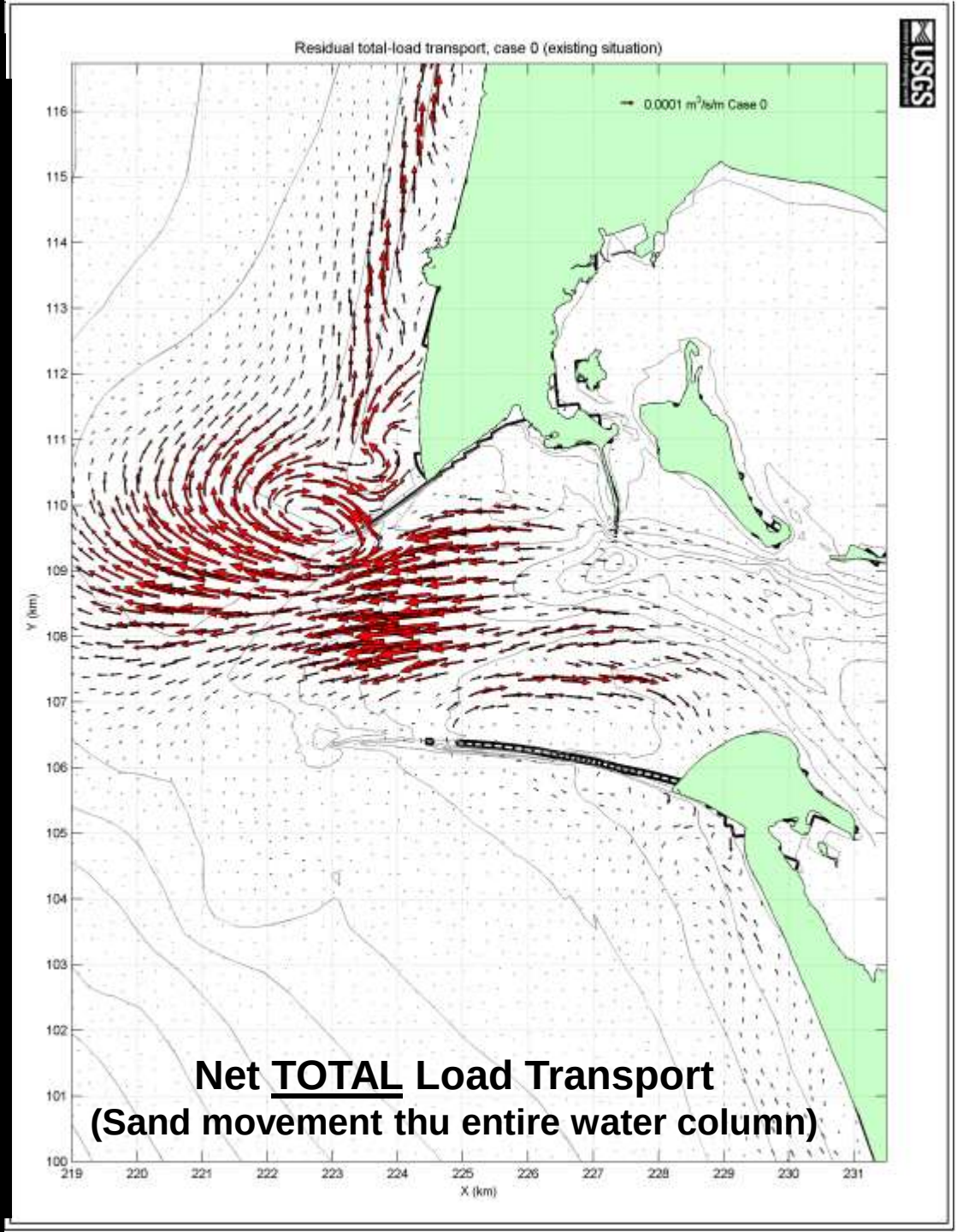
Definitive Hydrodynamic Model for Sediment Transport at MCR

Fall-Winter Conditions
One month

USGS Delft-3D

The "power" of a validated & trusted model Is an insight multiplyer

Data and Models confirm that waves are the sediment transport driver at MCR

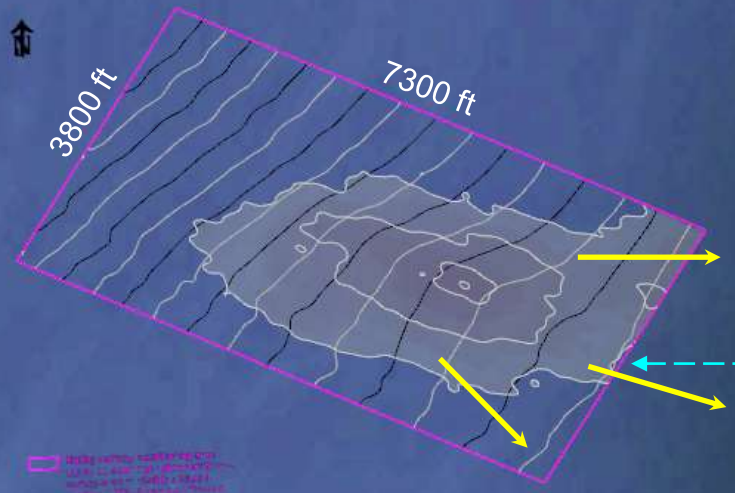


Net TOTAL Load Transport
(Sand movement thu entire water column)

MCR North Head Site (NHS) - Execution of Phase III

Thin-layer placement pilot project

10 MAR 21: 142 Kcy sand remains within initial mound footprint (50%)



1.6 miles

North Head

Benson Beach

North Jetty

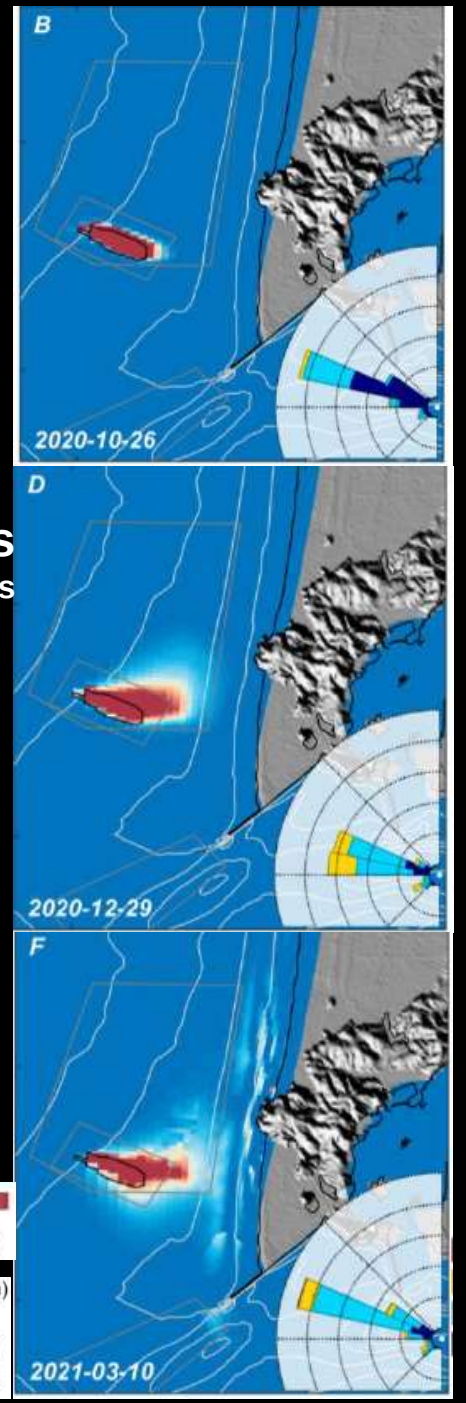
Google Earth

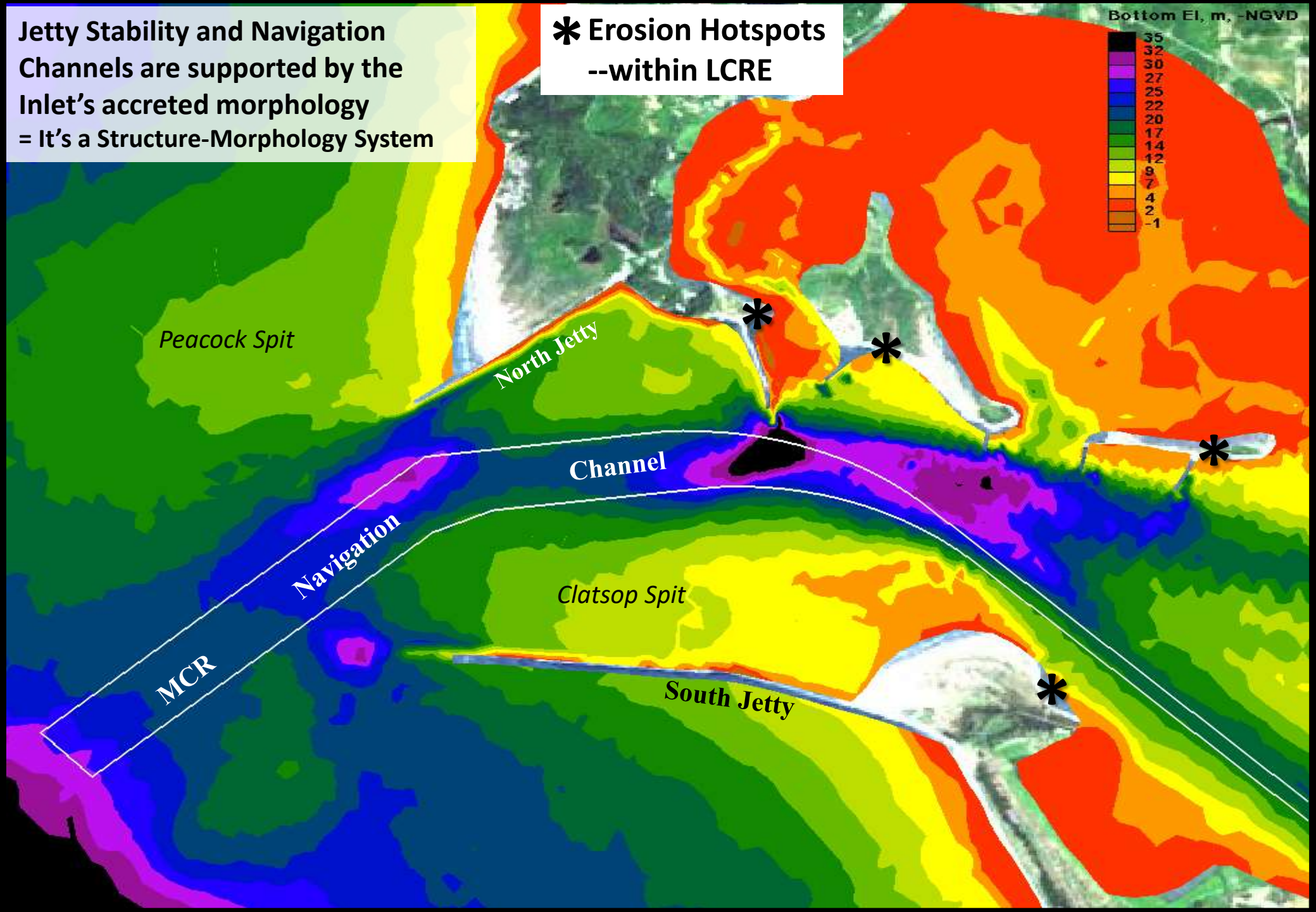
Based on monitoring results 22 SEP 20 to 10 MAR 21, 130 Kcy (50%) of Sand eroded from Phase III mound was being transported EAST toward shore (Benson Beach)

OBSERVED BATHYMETY CHANGE: SEP 20 – MAR 21

USGS D3D Model Results

50% moves Toward Benson Beach & 20% reaches Benson Beach





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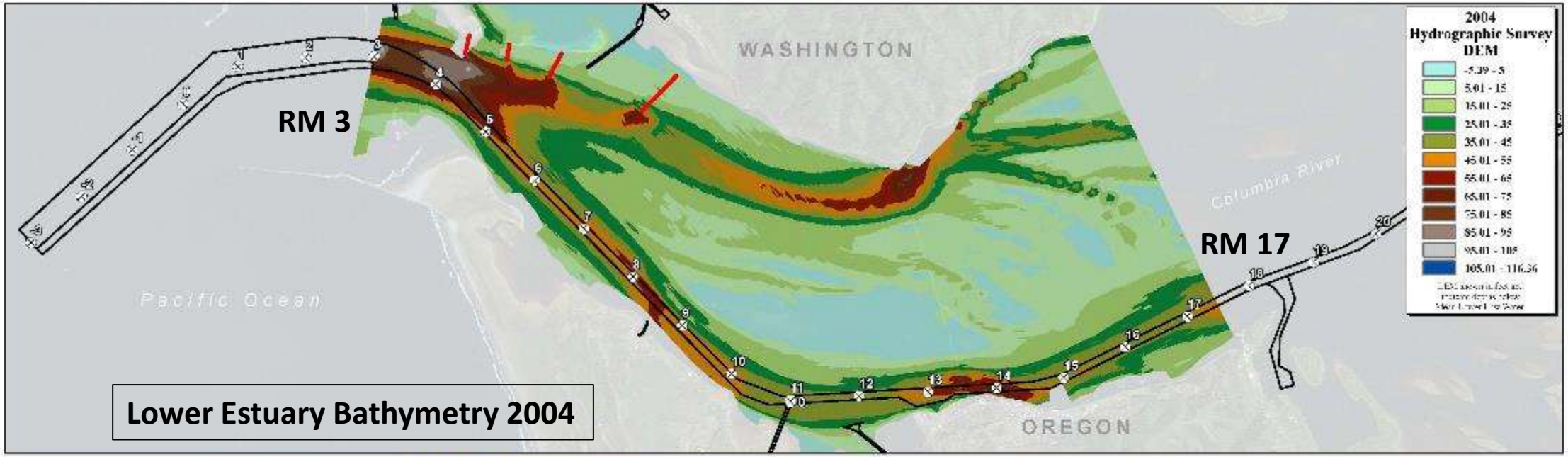
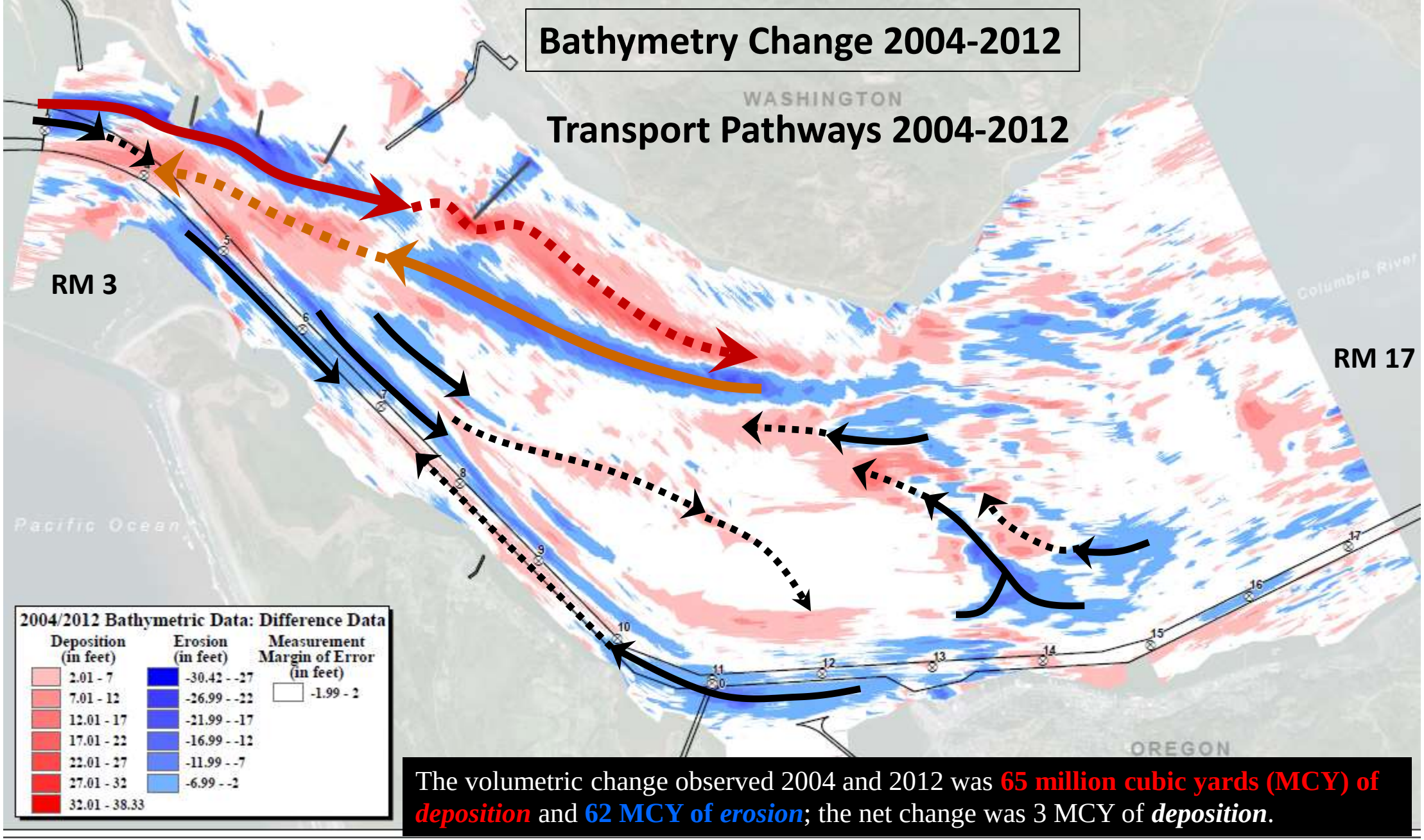


River Mile
Pile Dike
Federal Navigation Channel

Columbia River Estuary
2004/2012 Bathymetric Data Analysis

N
0 1 2
Miles


Bathymetry Change 2004-2012
WASHINGTON
Transport Pathways 2004-2012
RM 3
RM 17
Pacific Ocean
Columbia River
OREGON
2004/2012 Bathymetric Data: Difference Data
Deposition (in feet)
2.01 - 7
7.01 - 12
12.01 - 17
17.01 - 22
22.01 - 27
27.01 - 32
32.01 - 38.33
Erosion (in feet)
-30.42 - -27
-26.99 - -22
-21.99 - -17
-16.99 - -12
-11.99 - -7
-6.99 - -2
Measurement Margin of Error (in feet)
-1.99 - 2
The volumetric change observed 2004 and 2012 was 65 million cubic yards (MCY) of deposition and 62 MCY of erosion; the net change was 3 MCY of deposition.
River Mile
Pile Dike
Federal Navigation Channel
Columbia River Estuary
2004/2012 Bathymetric Data Analysis
0 0.5 1
Miles

CONCLUSIONS

CONNECTIONS WITH THE NEARSHORE OCEAN AT THE MOUTH OF THE COLUMBIA RIVER

1) Sand is a non-renewable resource - Sustaining morphology at the MCR is as much about using dredged sand to maintain the inlet's sediment budget, as dredging is for maintaining the federal navigation channel.

2) Do No Harm – Apply actionable science to manage dredged material while avoid impacting ecology

3) Good Science at MCR - Collaborative activity between stakeholders, regulators, proponents, and researchers.

4) Learn by Doing - To start a new dredged material-management initiative, conduct a series of pilot studies to confirm hypothesis & gain insight before going full-scale "operational".

5) It Never Ends - The MCR inlet and lower LCR estuary are still Actively Evolving – Navigation infrastructure requires continual adaptive management.

90% of the sand of dredged at MCR is now placed within the nearshore area (less than 60 ft water depth)

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