Overview of the SW WA Coastal Erosion Study and the Segue to RSM-related Activities Around the Mouth of the Columbia River

By George Kaminsky (WA DOE) and Samuel Y. Johnson (USGS)

USGS
science for a changing world

U.S. Geological Survey

- Science agency within Department of Interior
- No land management or regulatory responsibilities
- Provide unbiased science for policy and decision making

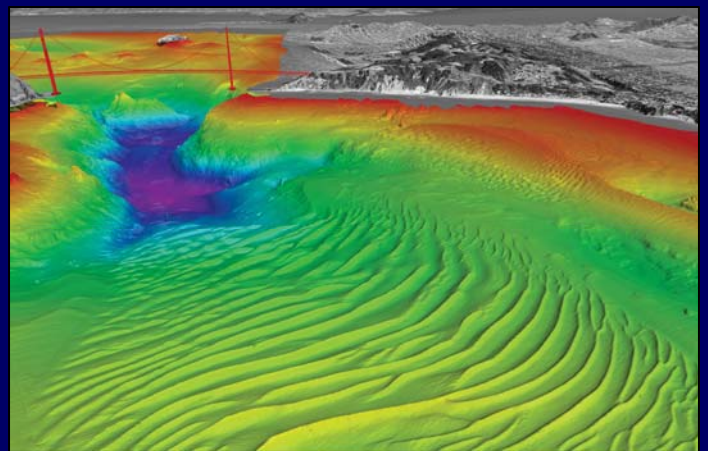
Western Region

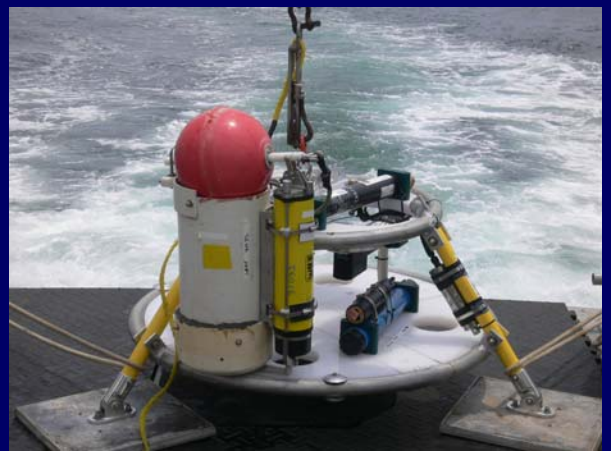
Western Coastal and Marine Geology Team

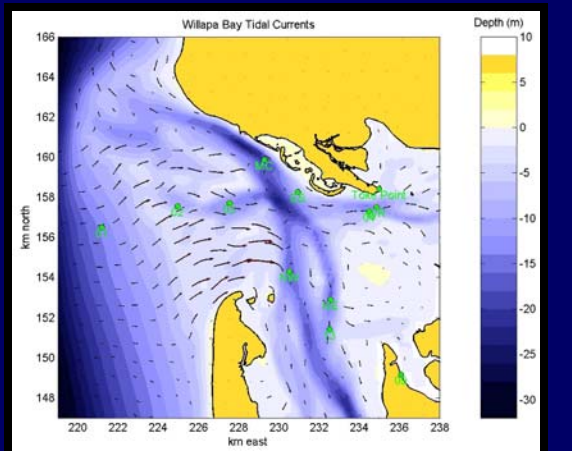
Environment, Hazards, Resources, Information

Regional Sediment Management

Mapping, Documenting Processes, Modeling







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Regional Sediment Management

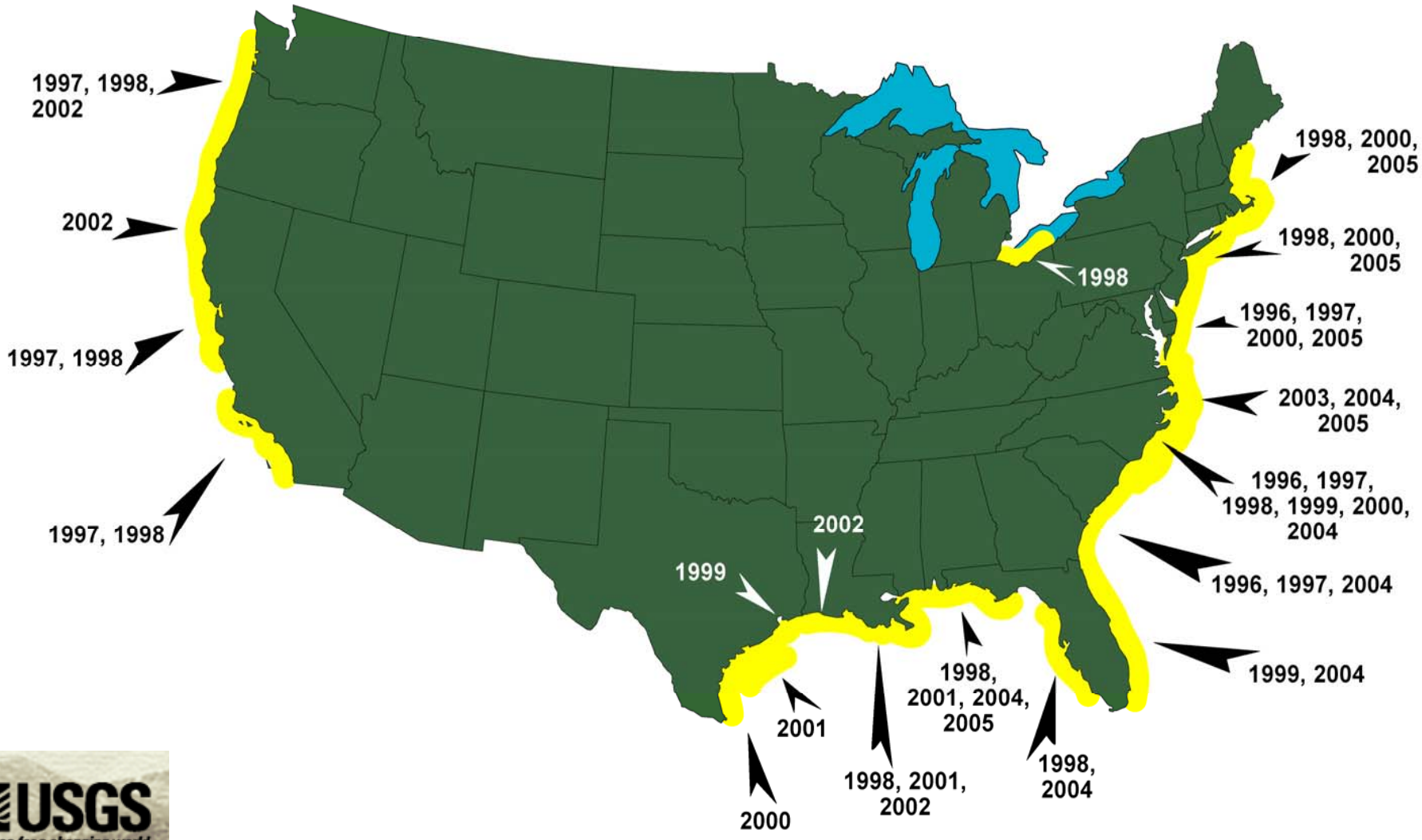
Issues:

- Coastal erosion - beaches and bluffs
- Beach nourishment
- Dredge disposal
- Ecosystem restoration
- Sea-level rise impacts

Investigations:

- Sediment and contaminant transport
- Sediment budgets
- Fate and transport of fines
- “Source to sink”

NATIONAL COASTAL LIDAR COVERAGE: ACE, USGS, NASA, NOAA, Texas Bureau of Economic Geology



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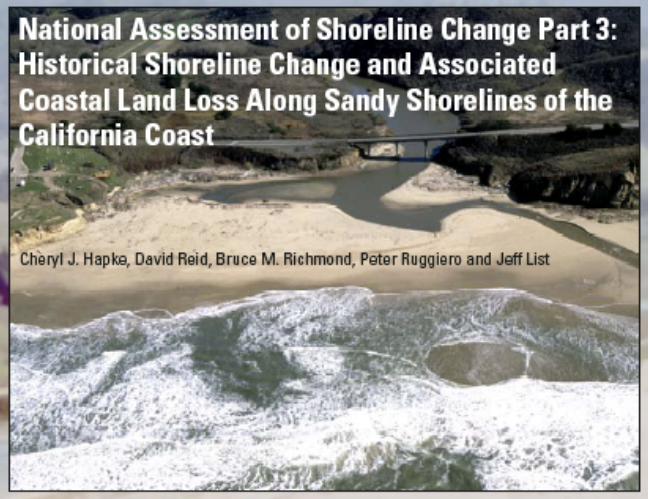
National Assessment of Shoreline Change Part 3: Historical Shoreline Change and Associated Coastal Land Loss Along Sandy Shorelines of the California Coast

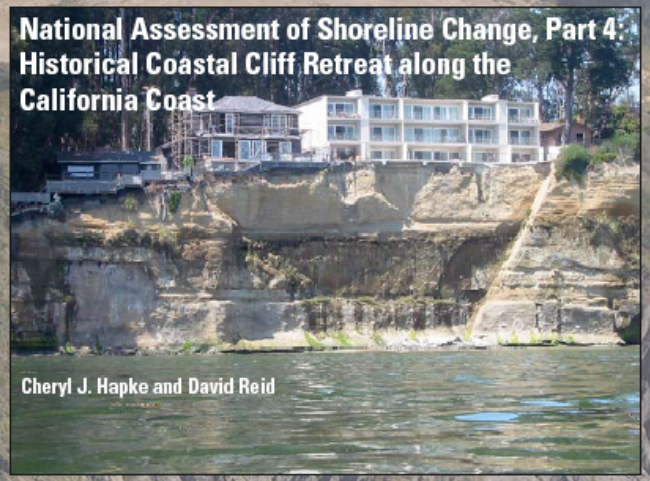


Cheryl J. Hapke, David Reid, Bruce M. Richmond, Peter Ruggiero and Jeff List

Open-File Report 2006-1219
U.S. Department of the Interior
U.S. Geological Survey

USGS
science for a changing world

National Assessment of Shoreline Change, Part 4: Historical Coastal Cliff Retreat along the California Coast

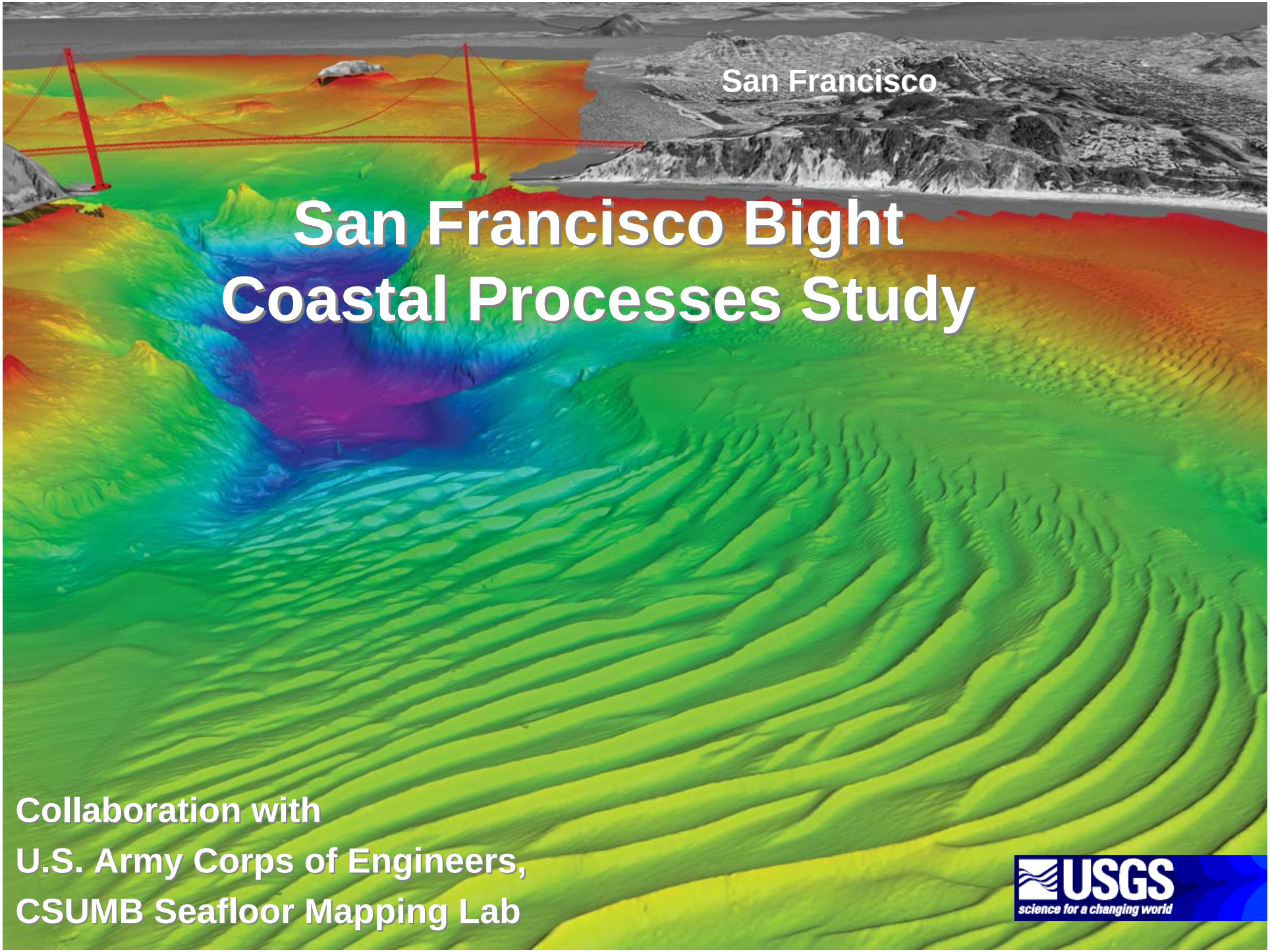


Cheryl J. Hapke and David Reid

Open-File Report 2007-1133
U.S. Department of the Interior
U.S. Geological Survey

CA Resources Agency
CA Boating & Waterways
CA Fish and Game
CA Coastal Commission
CA Lands Commission
CA Coastal Conservancy
CA Geological Survey

US Army Corps of Engineers
US EPA
US Geological Survey



San Francisco Bight Coastal Processes Study

Collaboration with
U.S. Army Corps of Engineers,
CSUMB Seafloor Mapping Lab

USGS
science for a changing world

Coastal Erosion Threatens The Southern Portion of The Great Highway, San Francisco, CA

3,100-foot Seawall built in the early 1990s to protect the central portion of The Great Highway

Problem: Loss of beach sediment combined with increasing storminess and rising sea level threatens highway infrastructure

Desired Solution: Soft measures such as sediment nourishment preferred over hard structures such as seawalls

Research needed: Regional sediment transport pathways and sediment budgets required to design environmentally sound and sustainable solution

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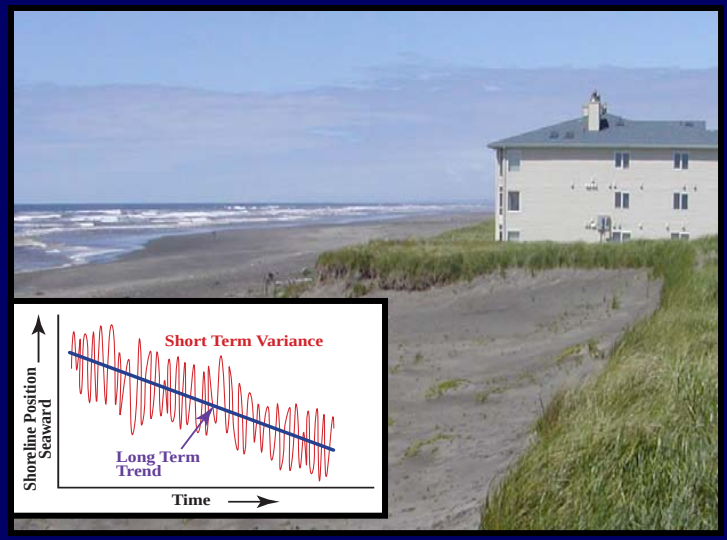
Coastal Change in the Urban Ocean - Santa Barbara and Ventura Counties
Partners: USGS, USACOE, CA B&W, BEACON, City of Carpinteria

Fate and Transport of Fines in the Nearshore Tijuana Estuary Demonstration Project

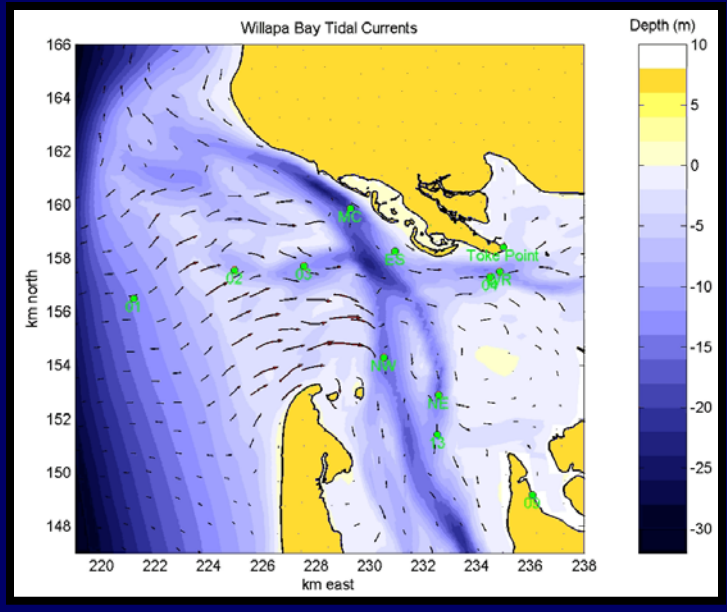
Southwest Washington Coastal Erosion Study

A Federal-State-Local Partnership

Understand regional coastal system dynamics; Determine natural and anthropogenic influences on coastal change; Predict coastal change at management scales (decades and km)



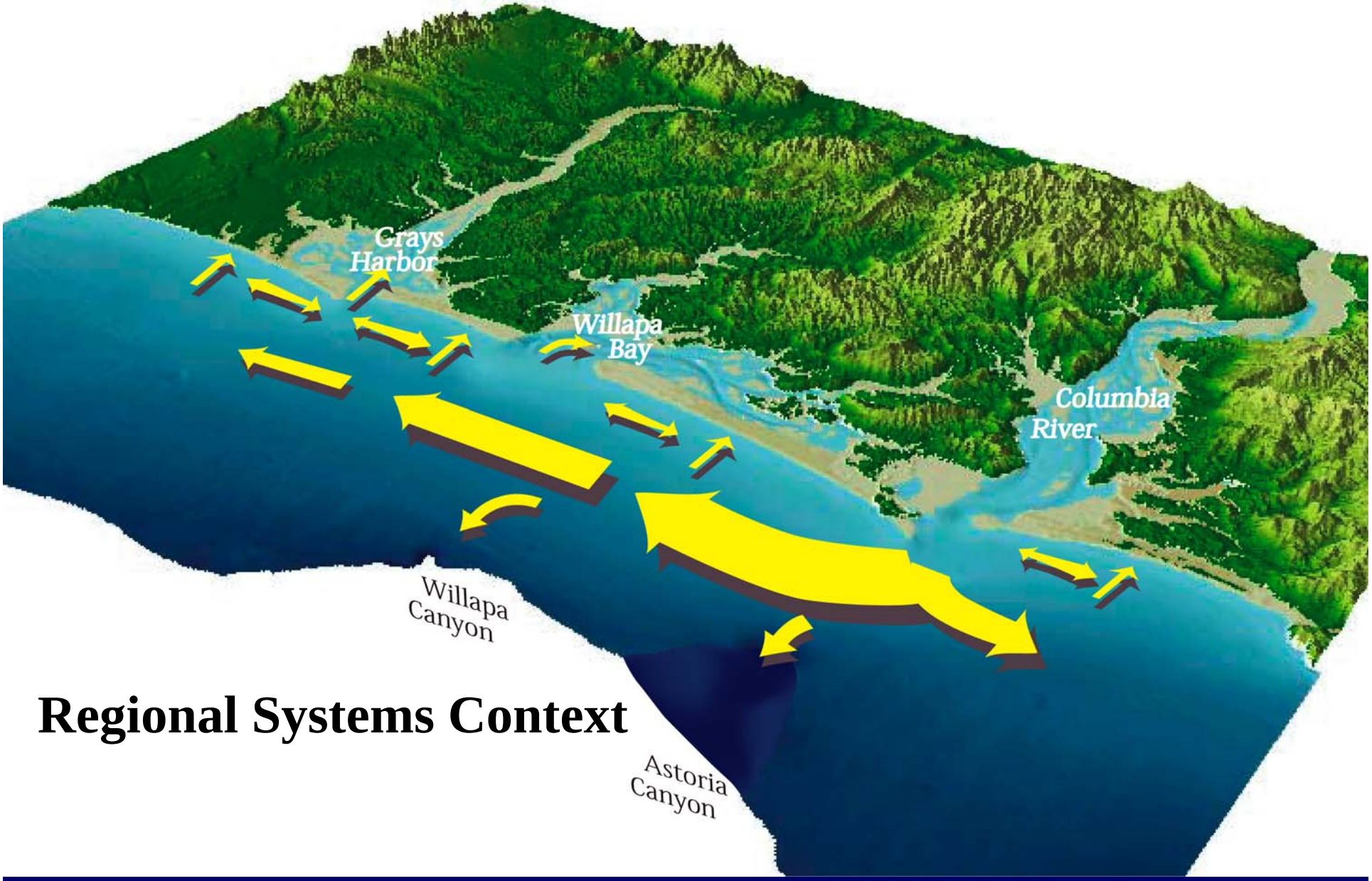
Project Chief: Guy Gelfenbaum



Outline

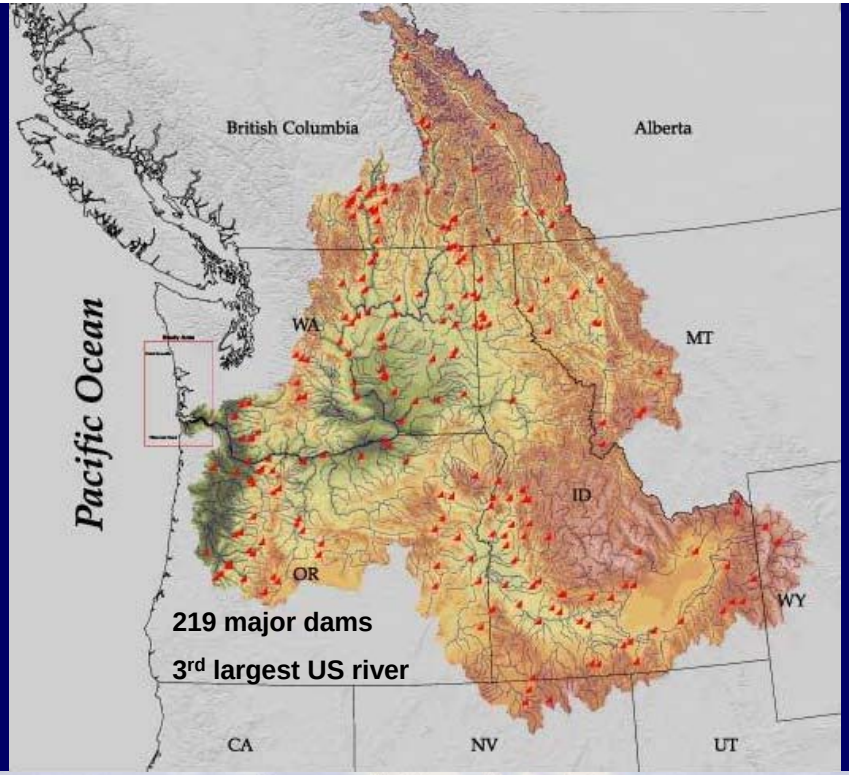
1. Results of the Southwest Washington Coastal Erosion Study
2. Results of studies to advance RSM at the MCR
3. RSM Situation Report

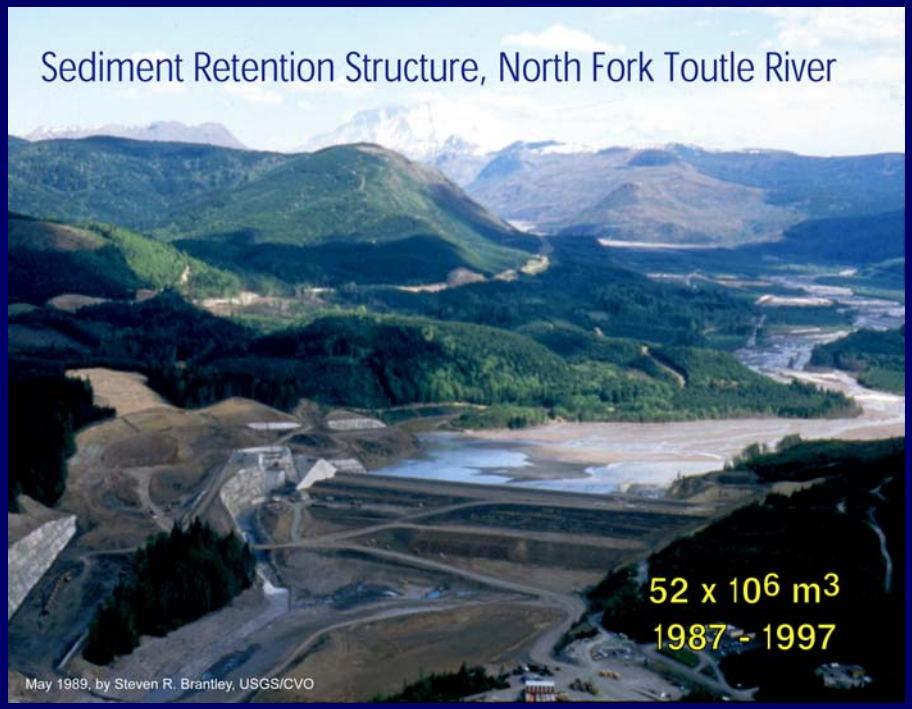
Columbia River Sediment Dispersal

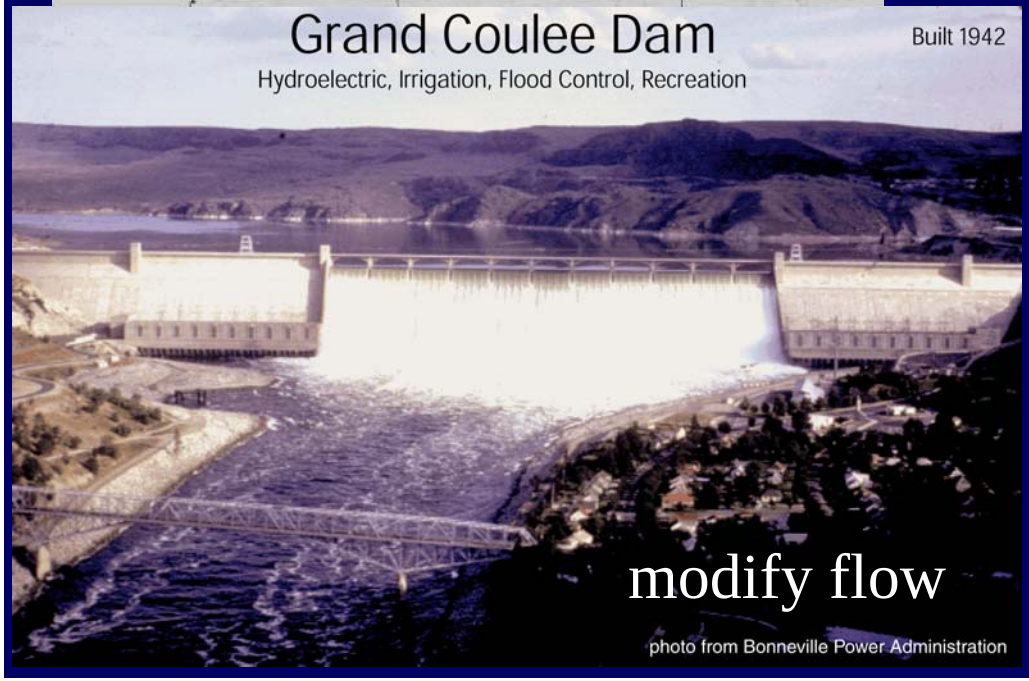


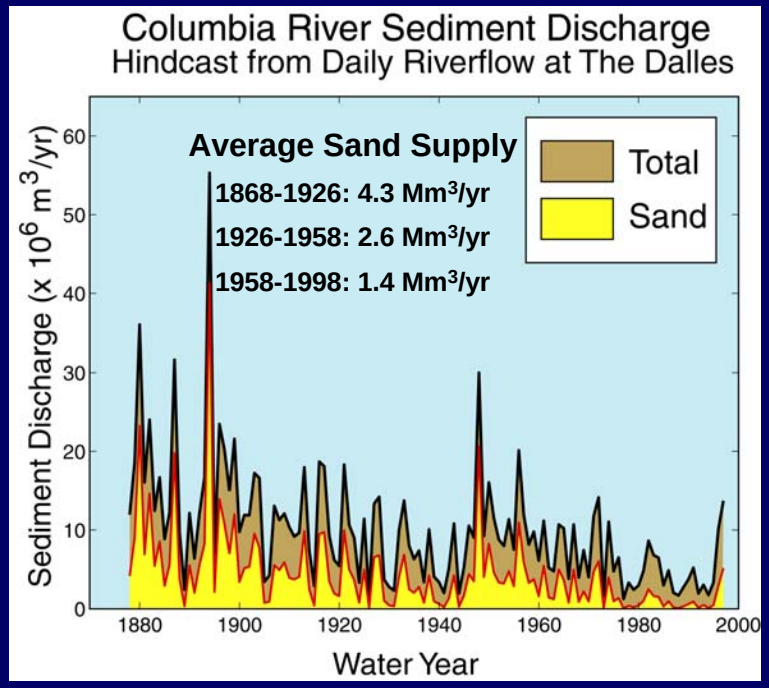
Regional Systems Context

(from Gelfenbaum and Kaminsky, 2001; after Sternberg; Nittrouer, etc.)

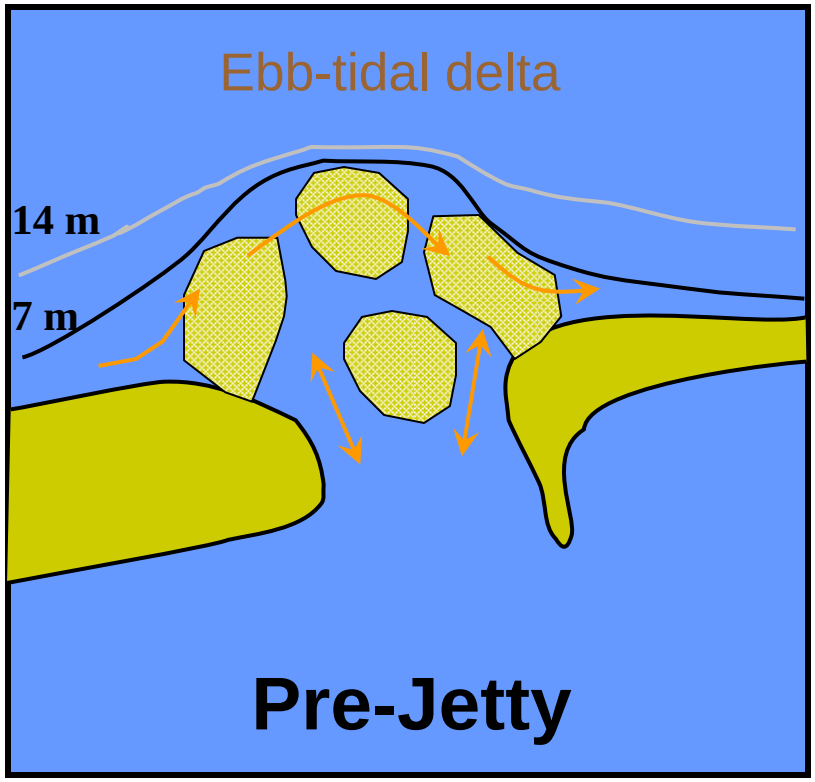

British Columbia
Alberta
Pacific Ocean
WA
MT
ID
OR
WY
CA
NV
UT
219 major dams
3rd largest US river

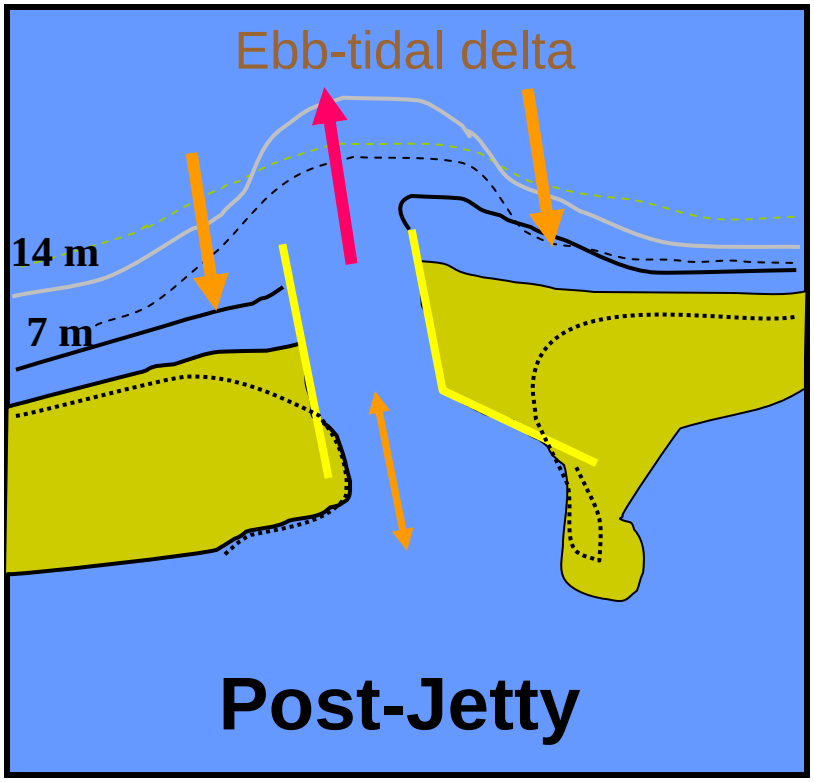

Sediment Retention Structure, North Fork Toutle River
52 x 10^6 m^3
1987 - 1997
May 1989, by Steven R. Brantley, USGS/CVO


Grand Coulee Dam
Built 1942
Hydroelectric, Irrigation, Flood Control, Recreation
modify flow
photo from Bonneville Power Administration


Columbia River Sediment Discharge
Hindcast from Daily Riverflow at The Dalles
Average Sand Supply
1868-1926: 4.3 Mm3/yr
1926-1958: 2.6 Mm3/yr
1958-1998: 1.4 Mm3/yr
Total
Sand
Sediment Discharge (x 10^6 m^3/yr)
0
10
20
30
40
50
60
1880
1900
1920
1940
1960
1980
2000
Water Year

Morphology Change Caused by Jetties





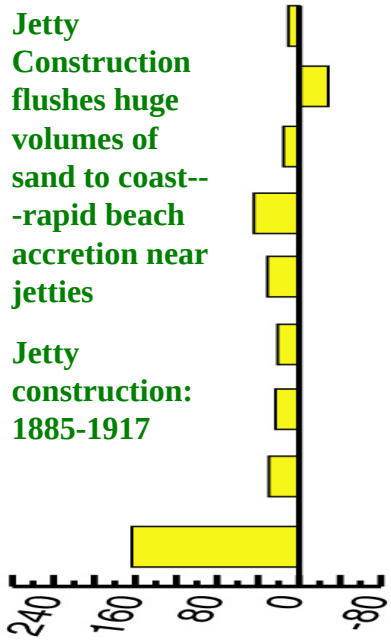
- Several shallow channels
- Shallow ebb-tidal delta
- Attached sub-aqueous shoals
- Alongshore sand bypassing

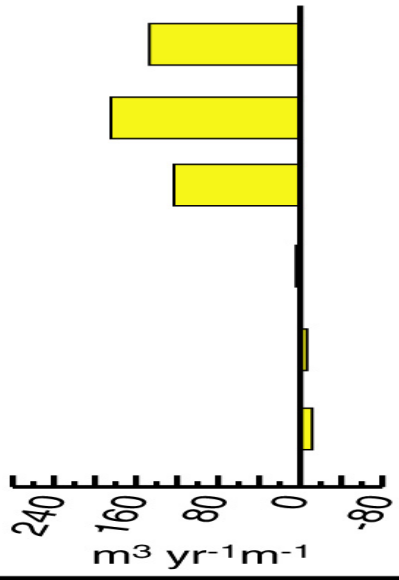
- Single deep channel
- Deep ebb-tidal delta
- Shoals migrate onshore
- Reduced sand bypassing

1878 - 1926

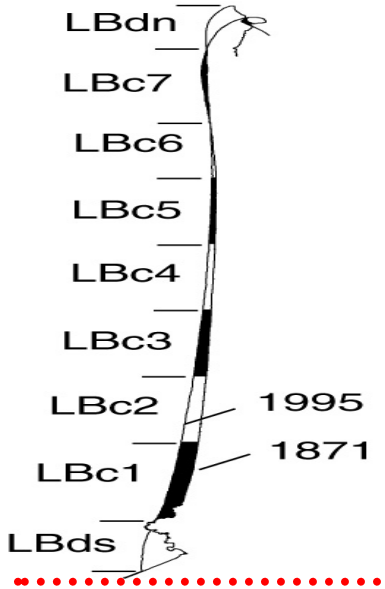
Jetty Construction flushes huge volumes of sand to coast---rapid beach accretion near jetties

Jetty construction: 1885-1917

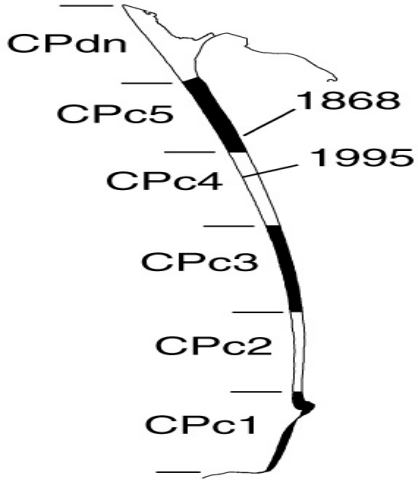




Long Beach Sub-cell



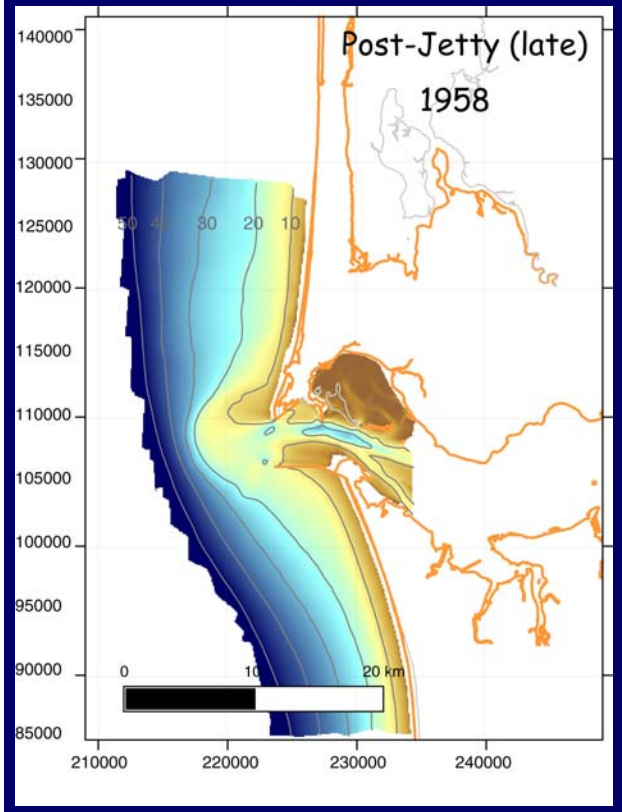
Columbia River



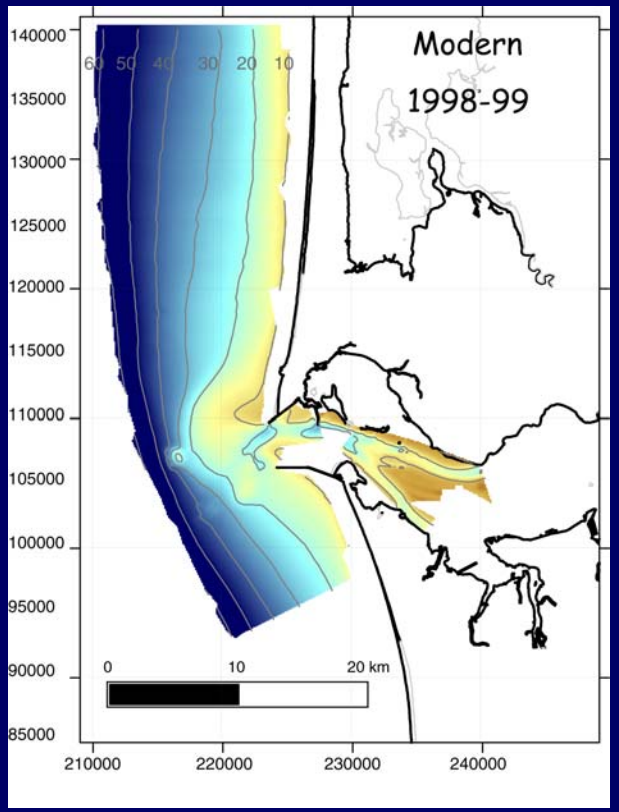
Clatsop Plains Sub-cell

Bathymetric Change: 1958-1999

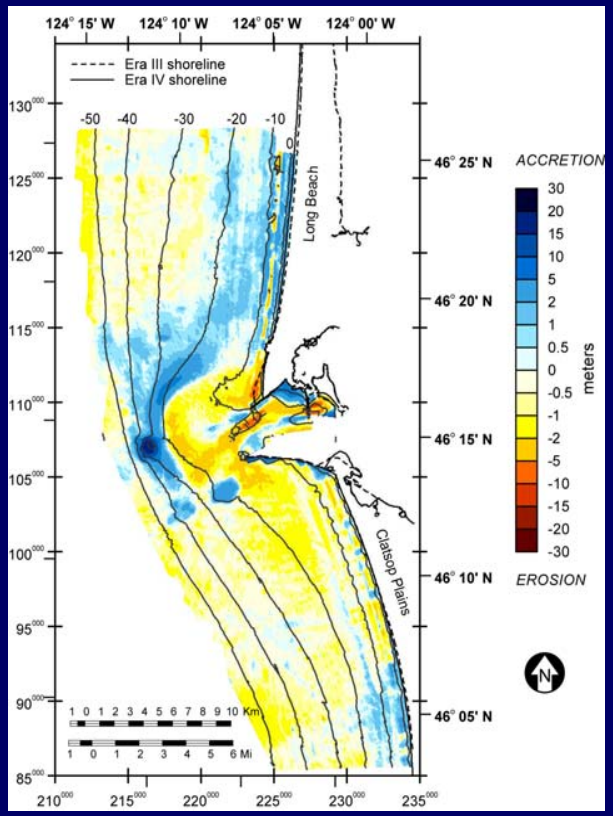
Post-Jetty



Modern

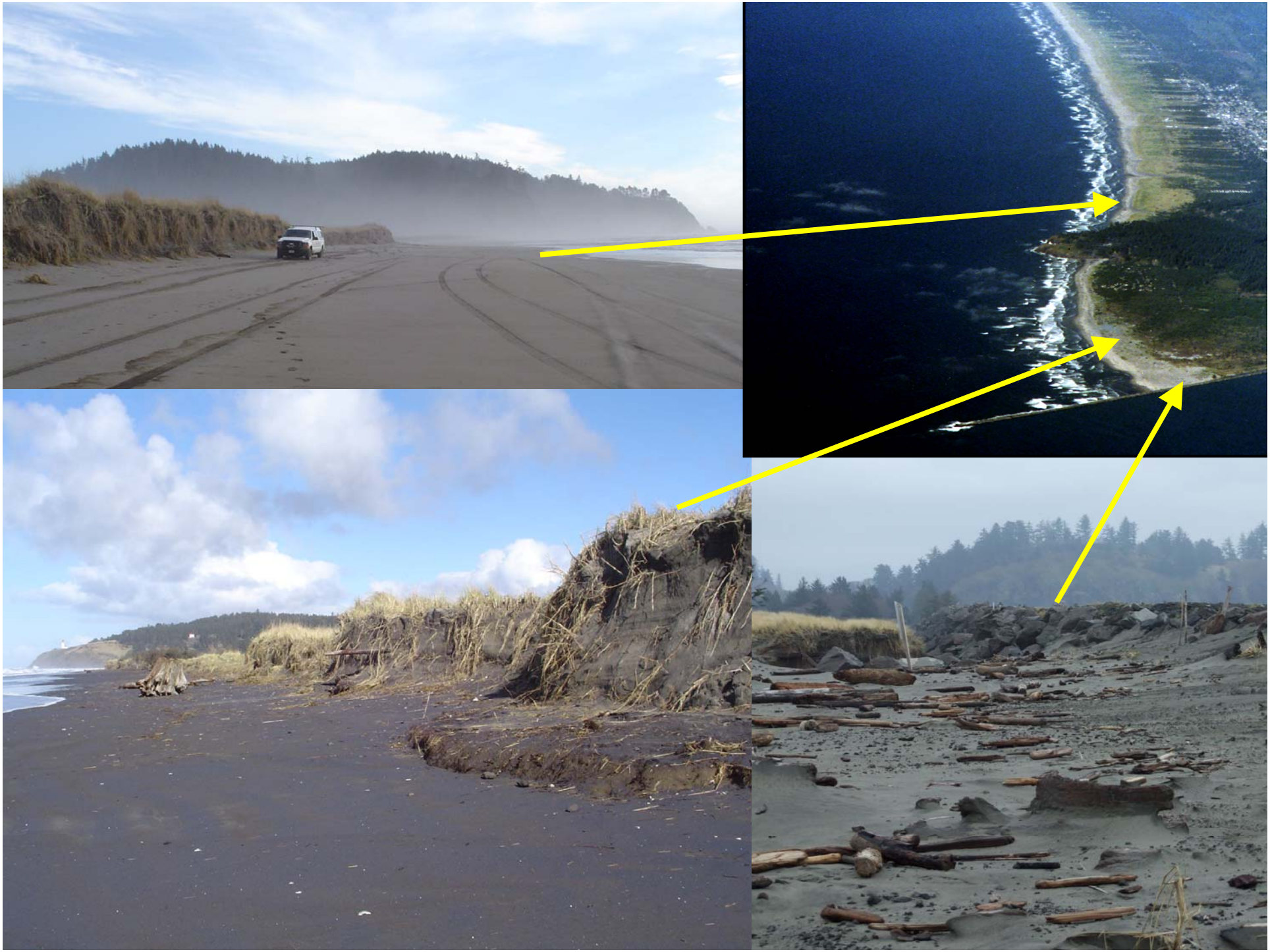


Bathy Change



Net Sediment Deficit
at MCR and Clatsop Plains Inner Shelf

(from Buijsman et al., 2001)



Future Shoreline Position PDF:
Deterministic Model Applied in a Probabilistic Sense

Model Simulations

70 Wave Climate Scenarios

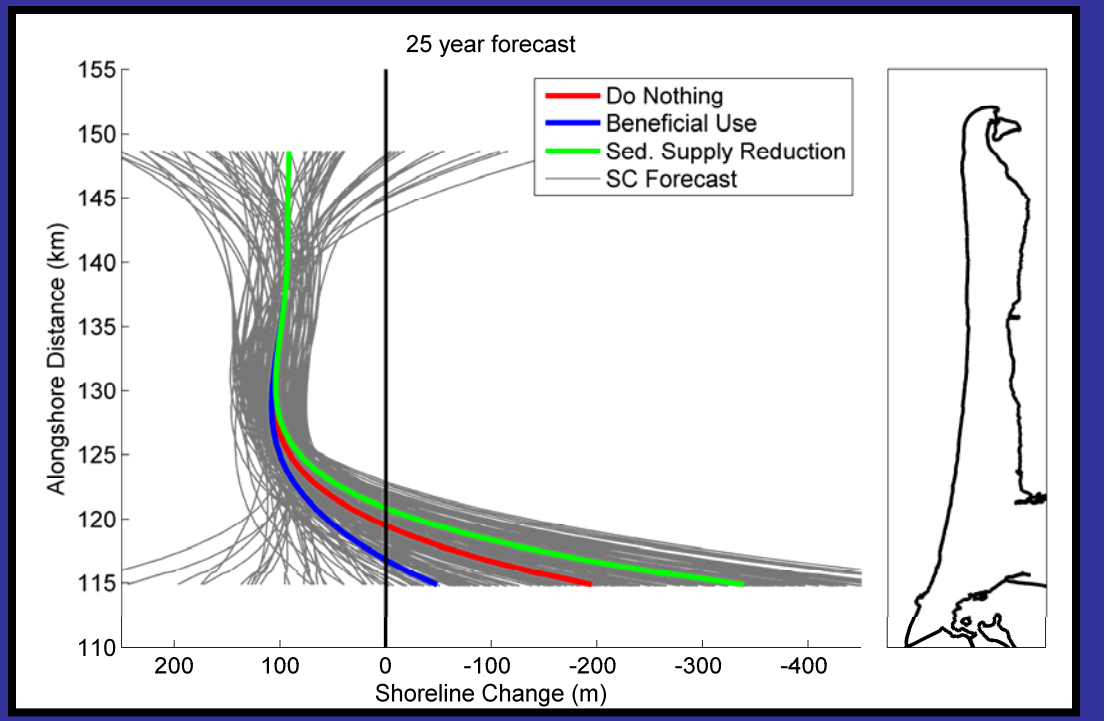
- *Mean Hs +- 0.5m*
- *Mean Tp +- 2s*
- *Mean Dp +- 3 deg.*

→

3 Sediment Supply Scenarios

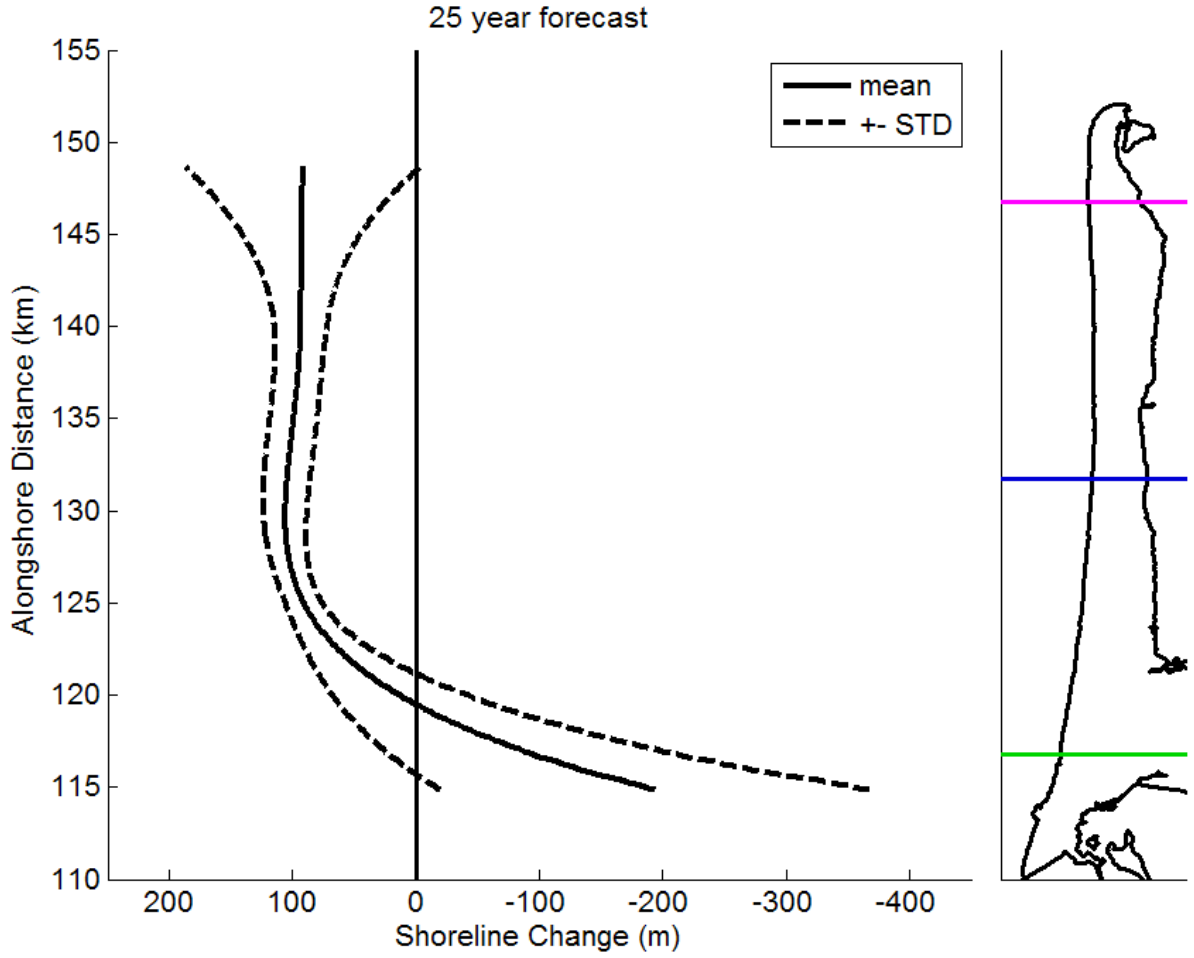
- *Beneficial Use +30%*
- *Do Nothing*
- *Sediment Supply Reduction -30%*

210 Forecast Shoreline Positions

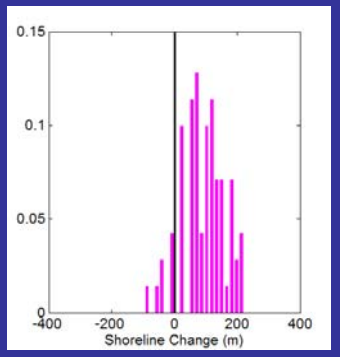


(from Ruggiero et al., in press)

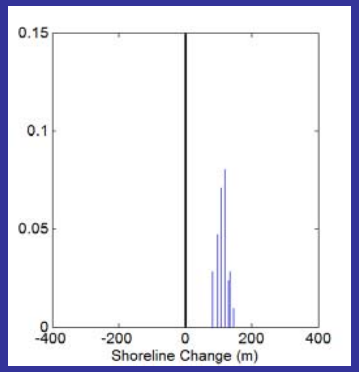
Shoreline Prediction PDFs:



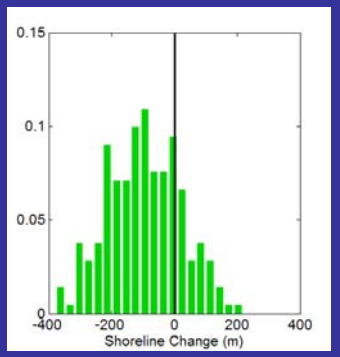
Erosion Probability by 2020



10%

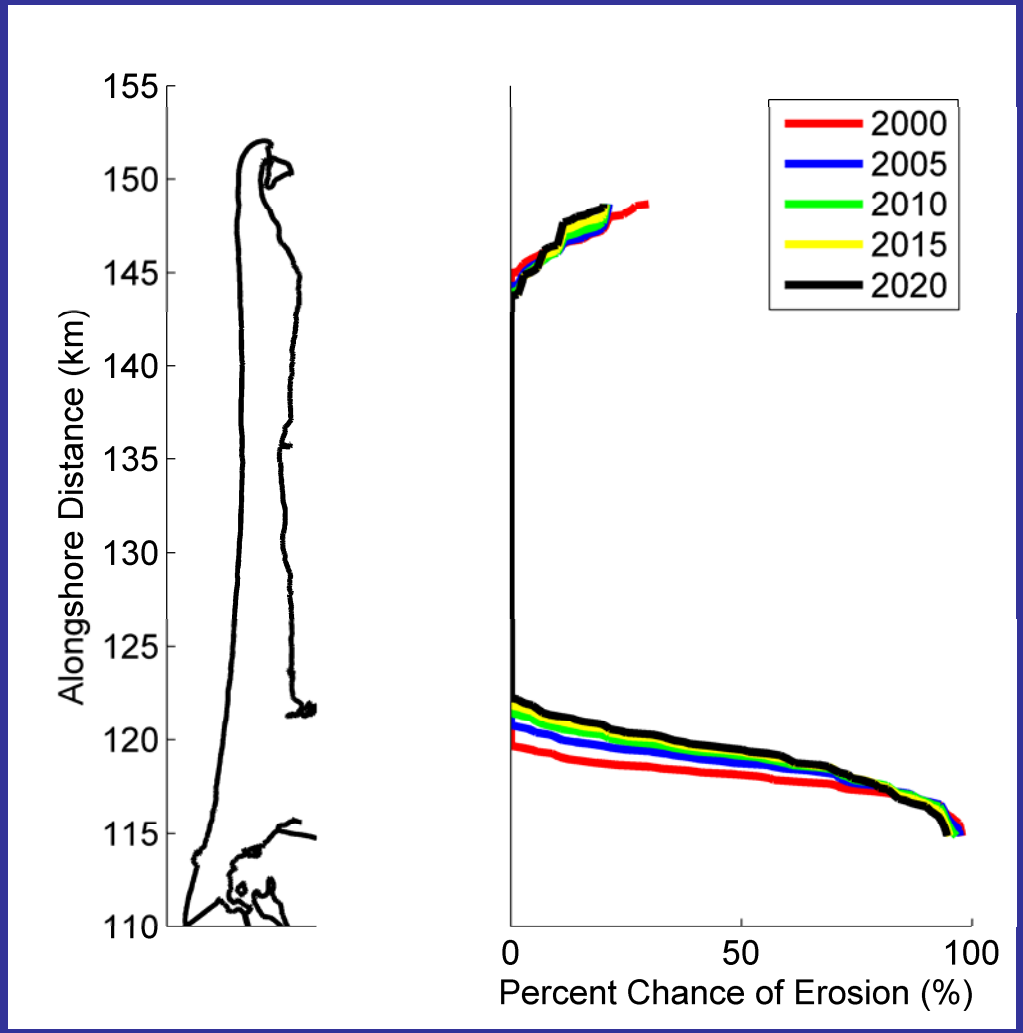


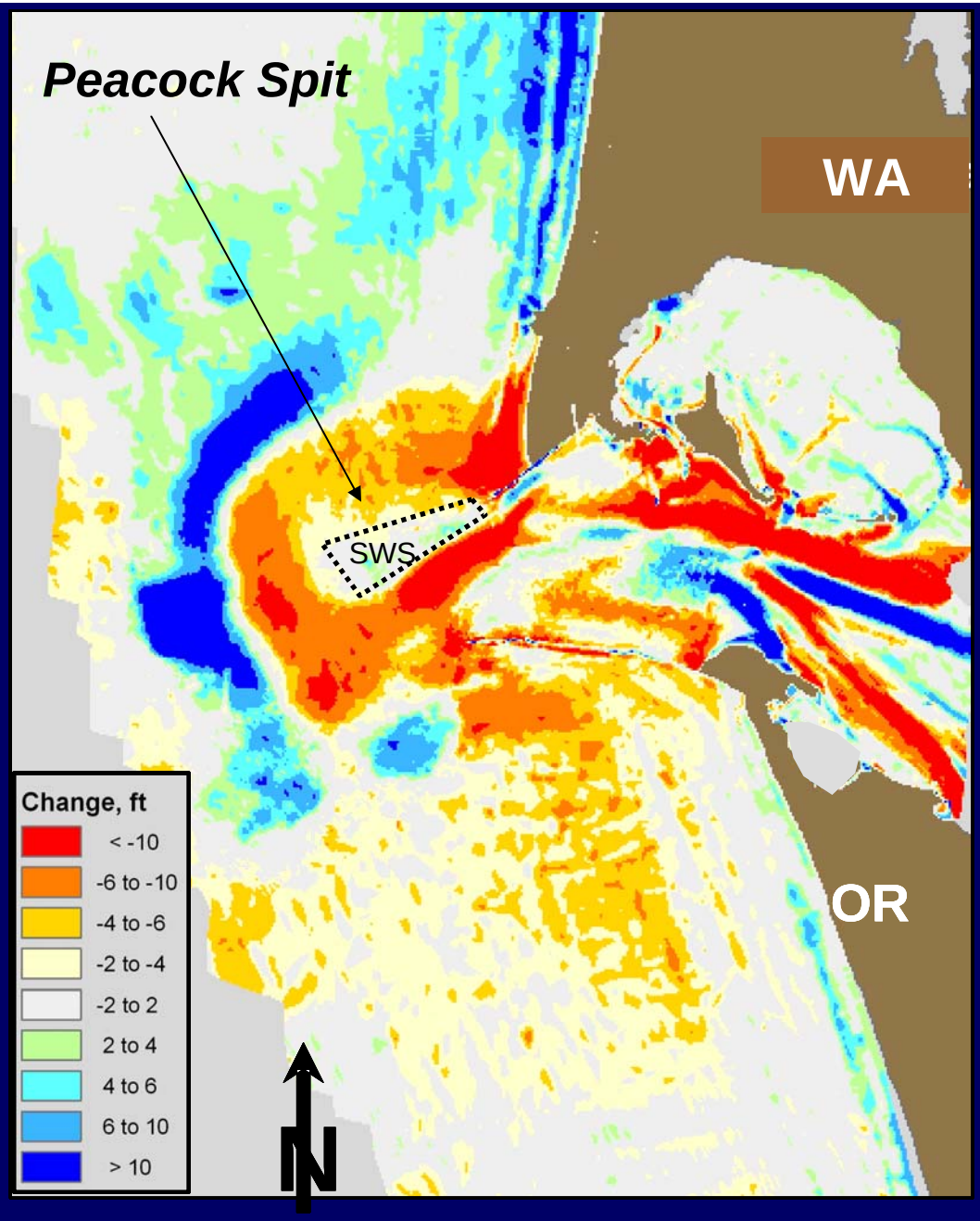
0%



79%

Time and Space Varying Probability of Erosion





1958 to 2003 Bathymetric Change

Use of the SWS has reduced the rate of recession affecting Peacock Spit.

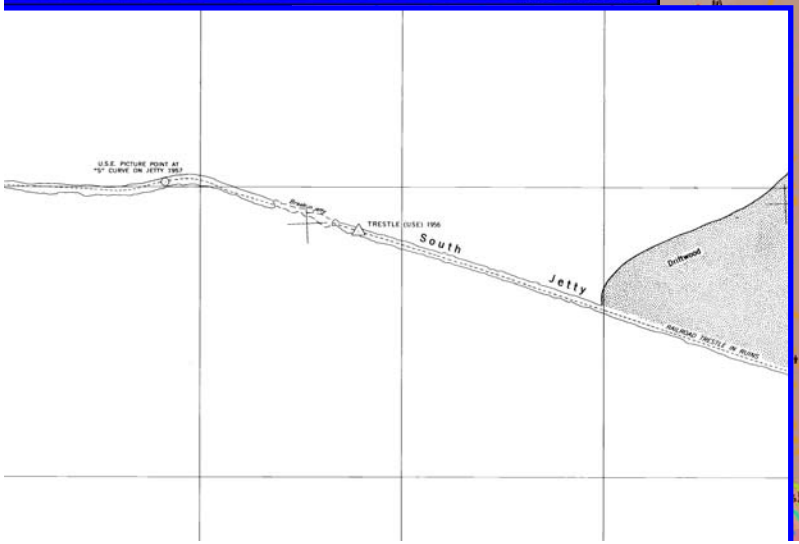
Protect the Spits/shoals, and they will protect the jetties and inlet.

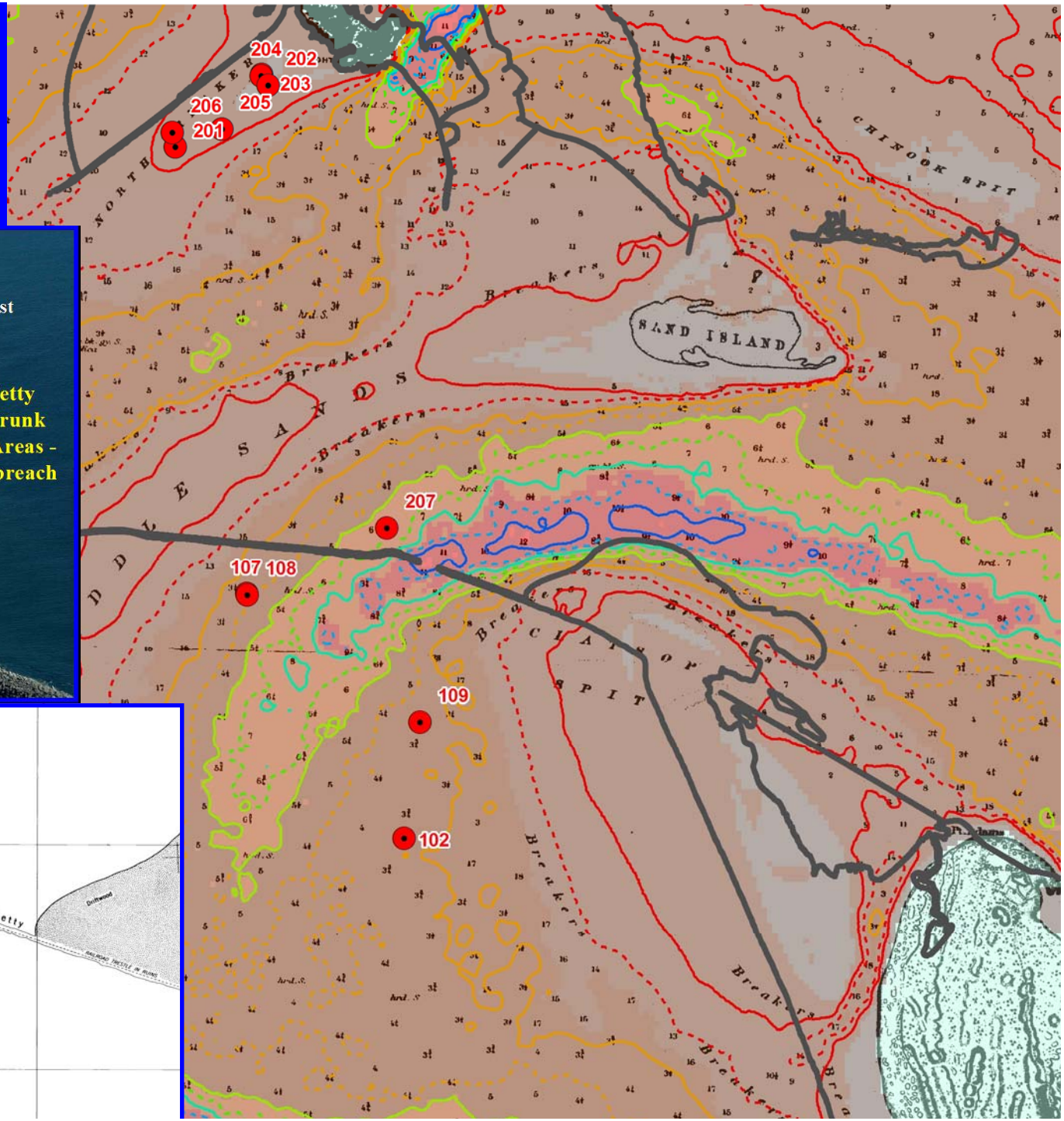
<u>BOTTOM LINE</u>:

RSM is critical to jetty resilience, sediment budget, and shoreline change.


Regional Sediment Management
RSM
RSM . . . for balanced, sustainable solutions
CIRP
Coastal Inlets Research Program
US Army Corps of Engineers
Northwestern Division
USGS
science for a changing world
APPLIED COASTAL
OREGON STATE UNIVERSITY
Open minds. Open doors.
O.H. Hinsdale
Wave Research Laboratory
NORTHWEST RESEARCH ASSOCIATES
Innovative Scientific Research and Development
MOFFATT & NICHOL
WASHINGTON STATE DEPARTMENT OF ECOLOGY
EVANS-HAMILTON, INC.
SINCE 1971
OCEANOGRAPHERS
PACIFIC INTERNATIONAL ENGINEERING
State Of Oregon
Ohio State University
US Army Corps of Engineers
Portland District

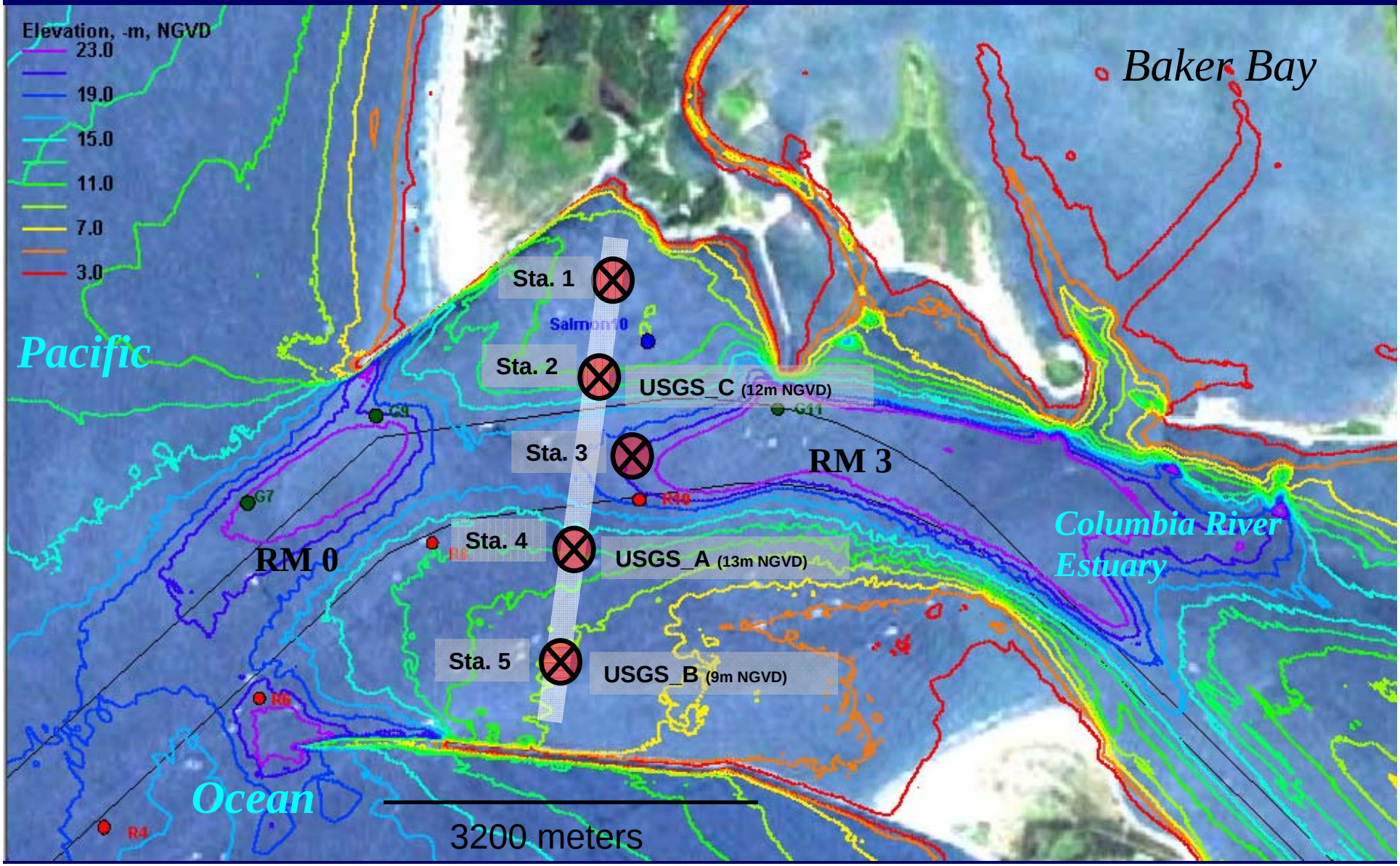
Analysis of jetty foundation from vibracores





MCR "Mega Transect" field experiment

August – September 2005



26 MAY 2006 ARGUS Beach Monitoring System at North Head cameras 5 & 6

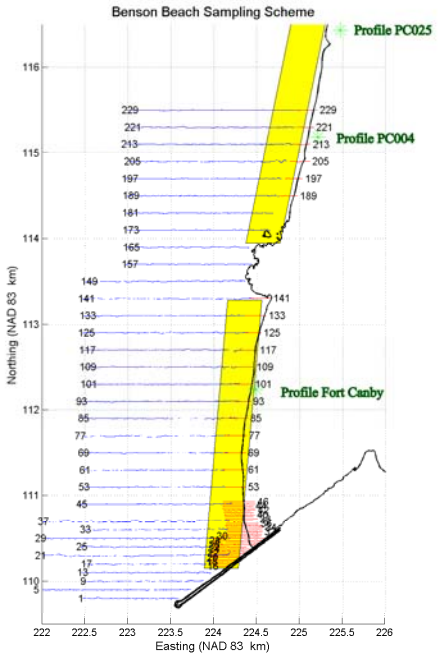
Additional Erosion (cutting) of Beach Scarp during winter '05-'06

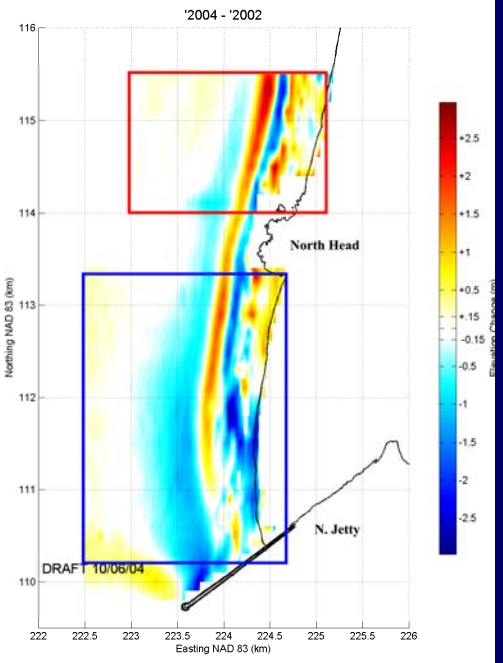
Sand from "Sand Bars" being transported onshore

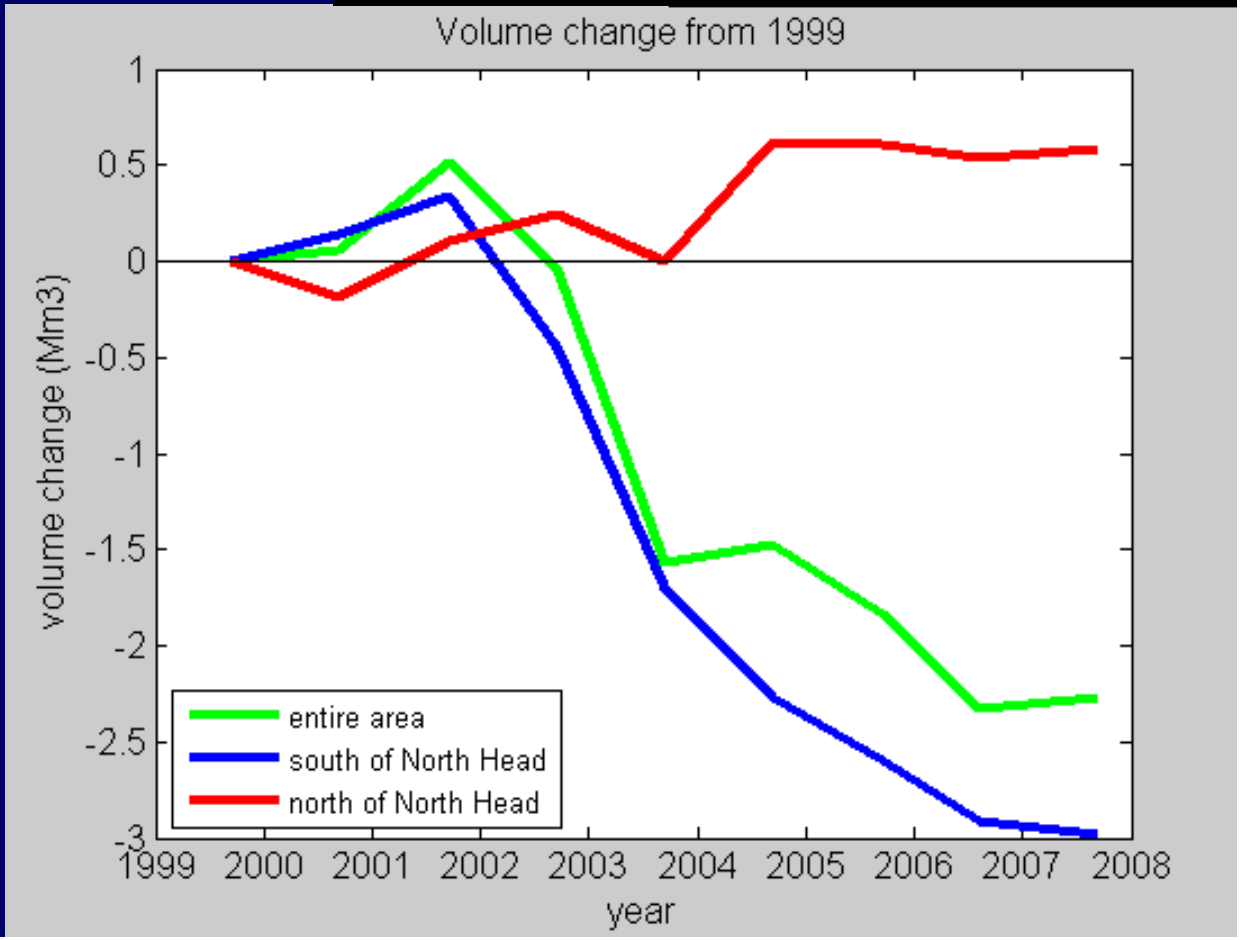
Note lighter color of sand migrating shoreward from sand bars covering darker sands

The darker color sands contain hematite and other heavy minerals. The darker sands are more dense and less mobile than the lighter color sands, and tend to stay on the beach during the winter wave season. The dredged sediment placed at the SWS has likely contributed to the sand supply of Peacock Spit. The lighter color sands may come from the dredged sand placed at the SWS.

Beach and Nearshore Morphology Monitoring







Round 3 Tracer Sampling Completed 7 MAY 2007

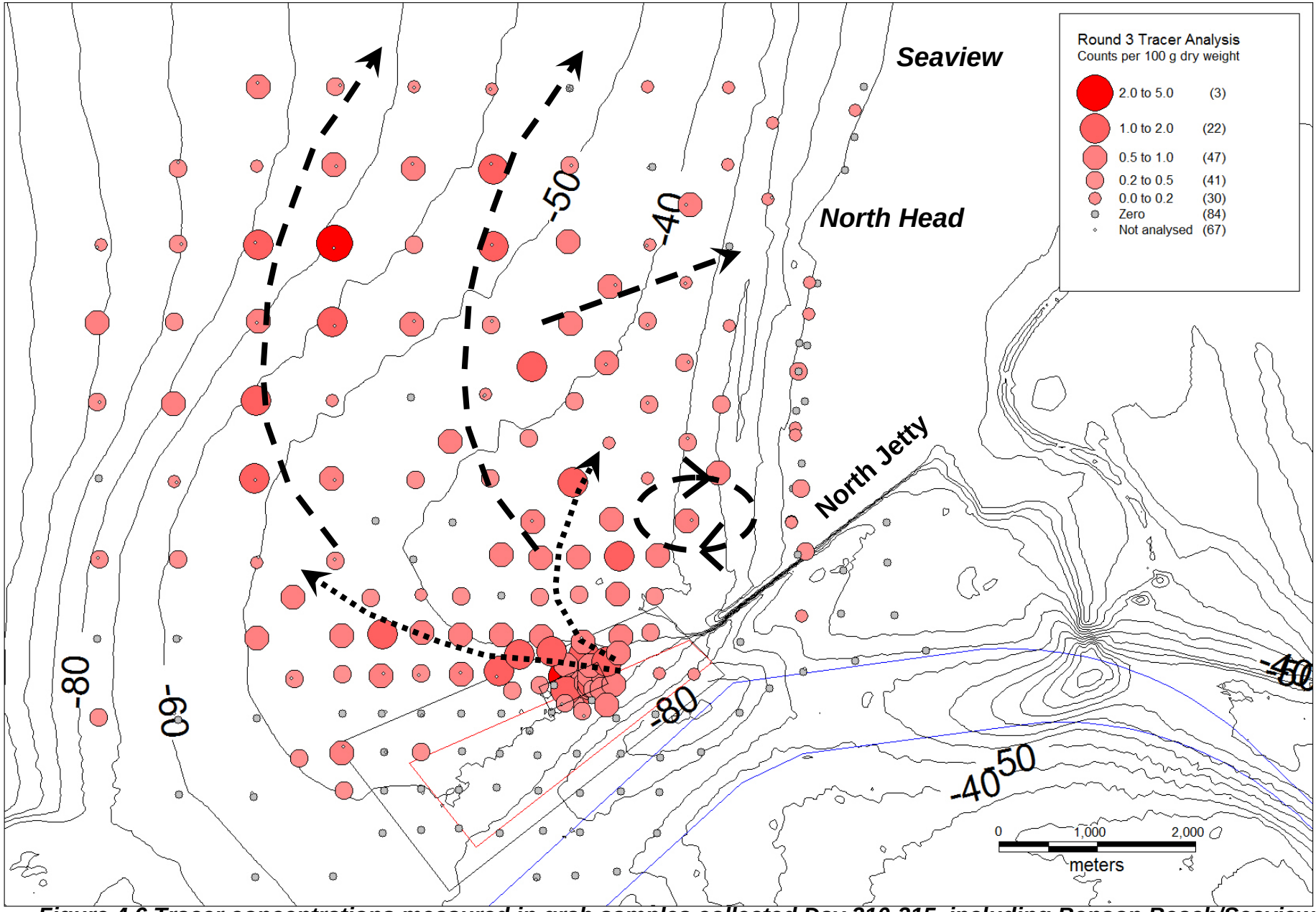
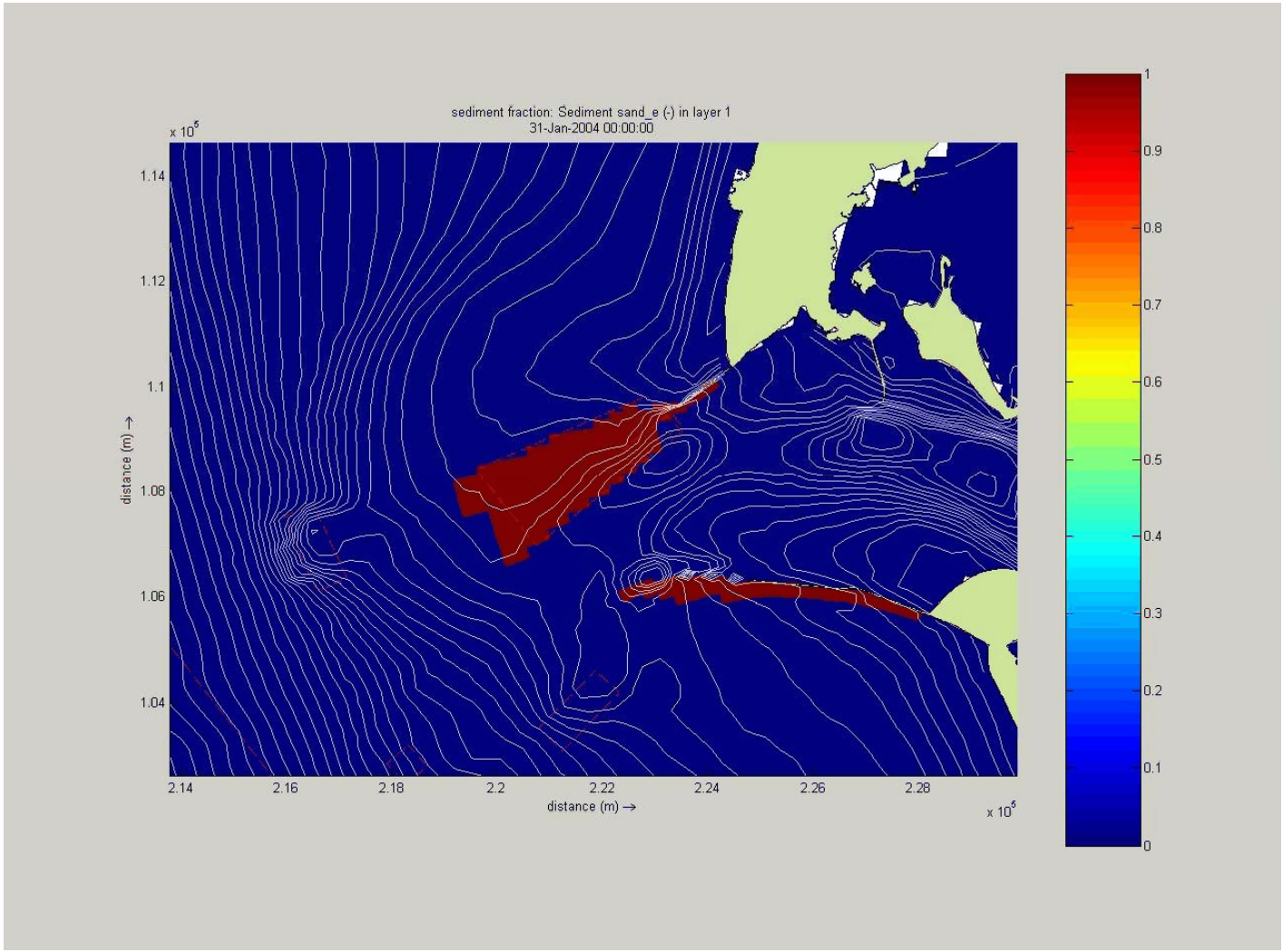


Figure 4.6 Tracer concentrations measured in grab samples collected Day 210-215, including Benson Beach/Seaview

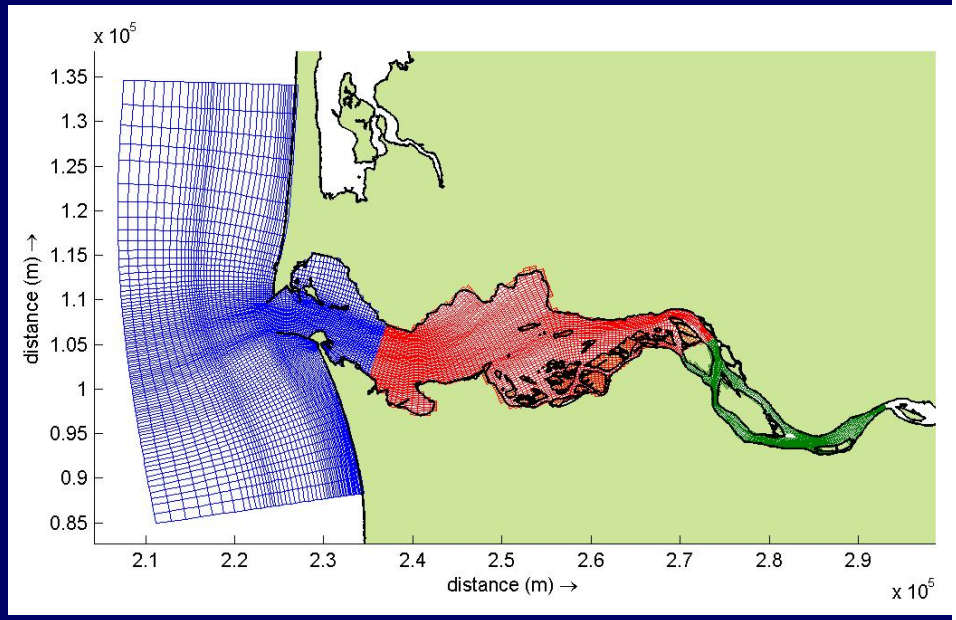
Sediment tracer simulation **DELFT 3-D Model USGS**

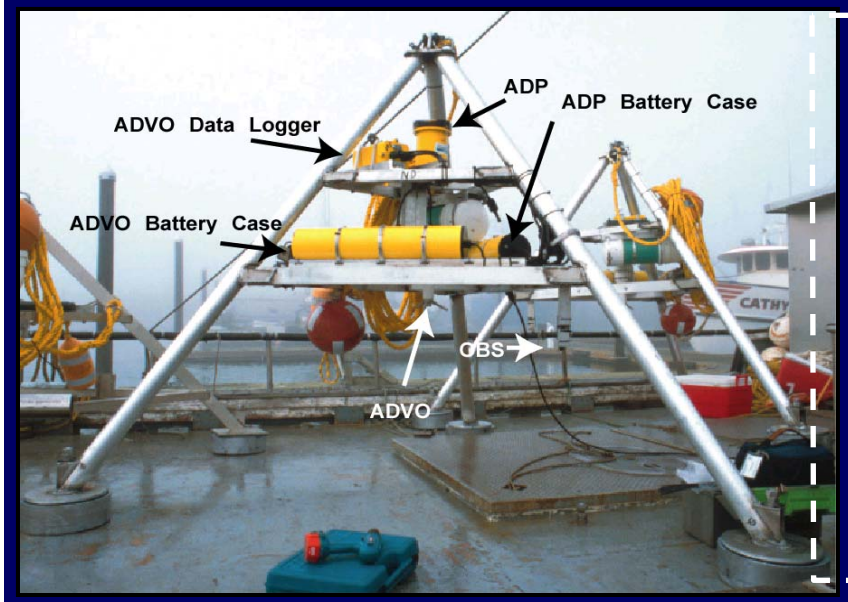


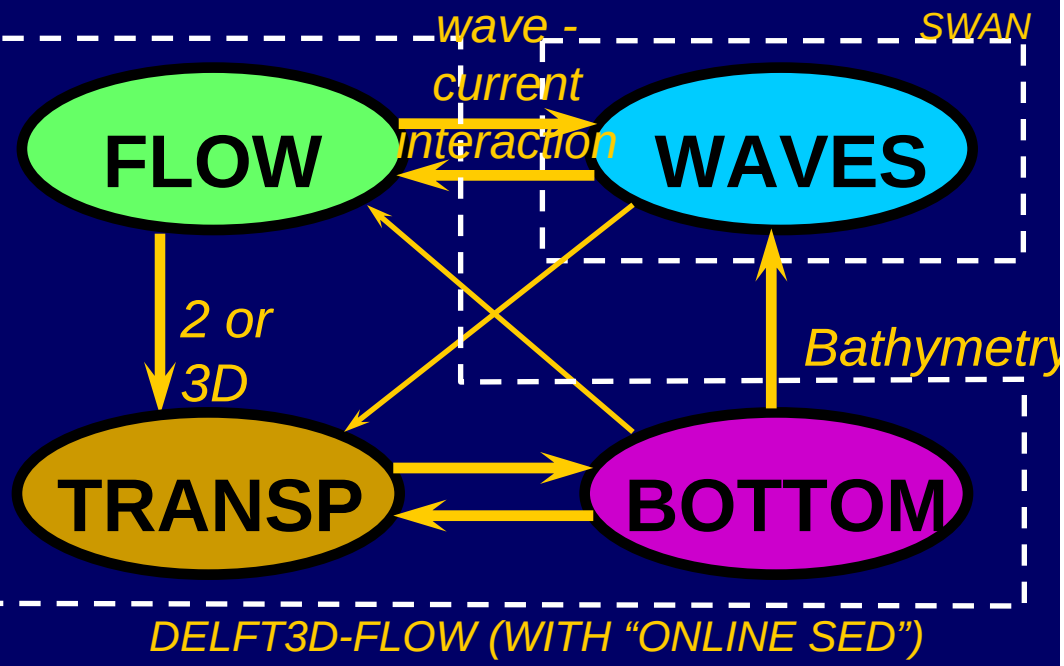
Initial distribution of “SWS” sand (and fixed layers) to “final” distribution in the top 5 cm of bed over 1 month.

Approach

- Data collection
  - Process identification
  - Model calibration
- Process-based morphological modeling

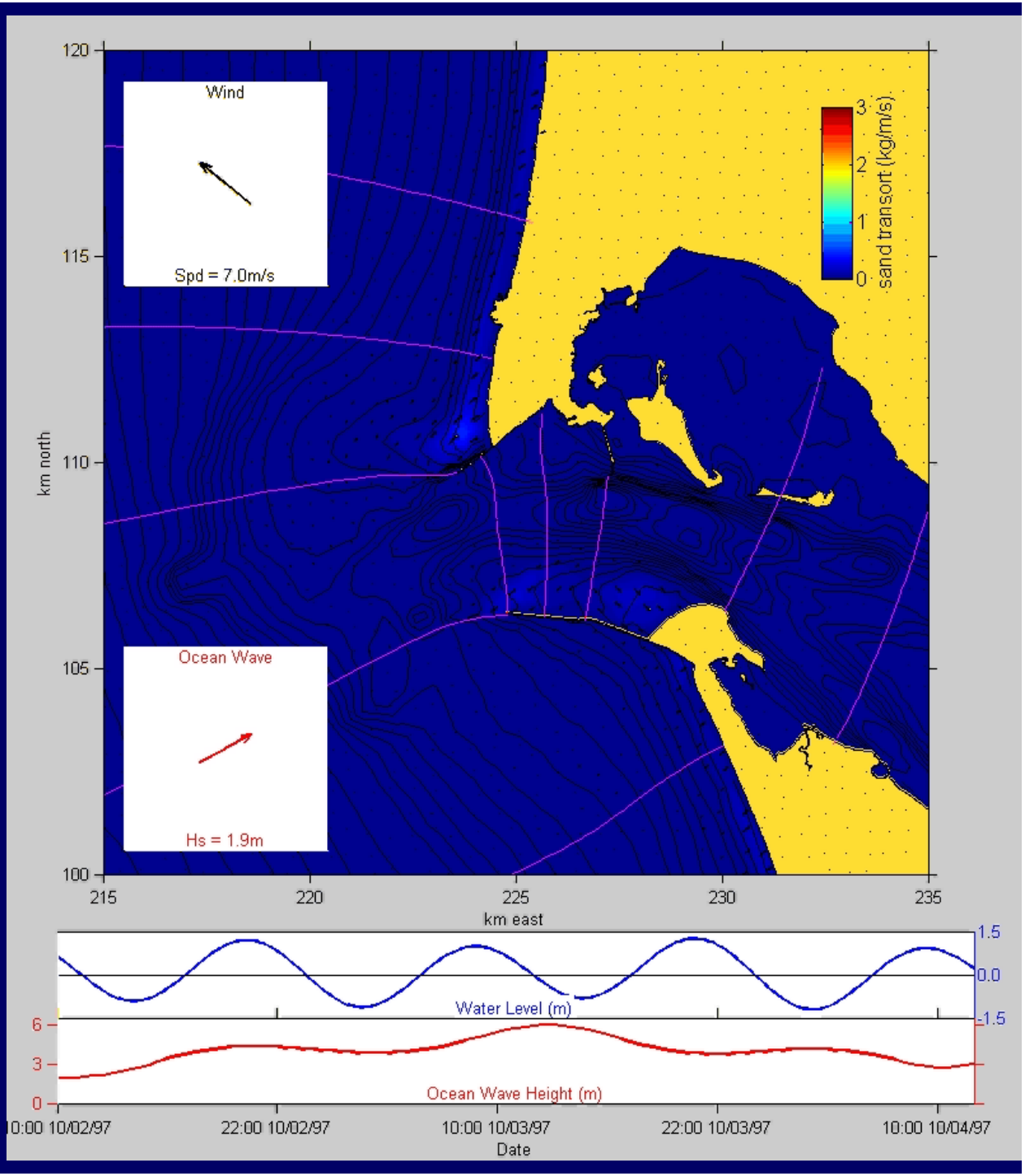




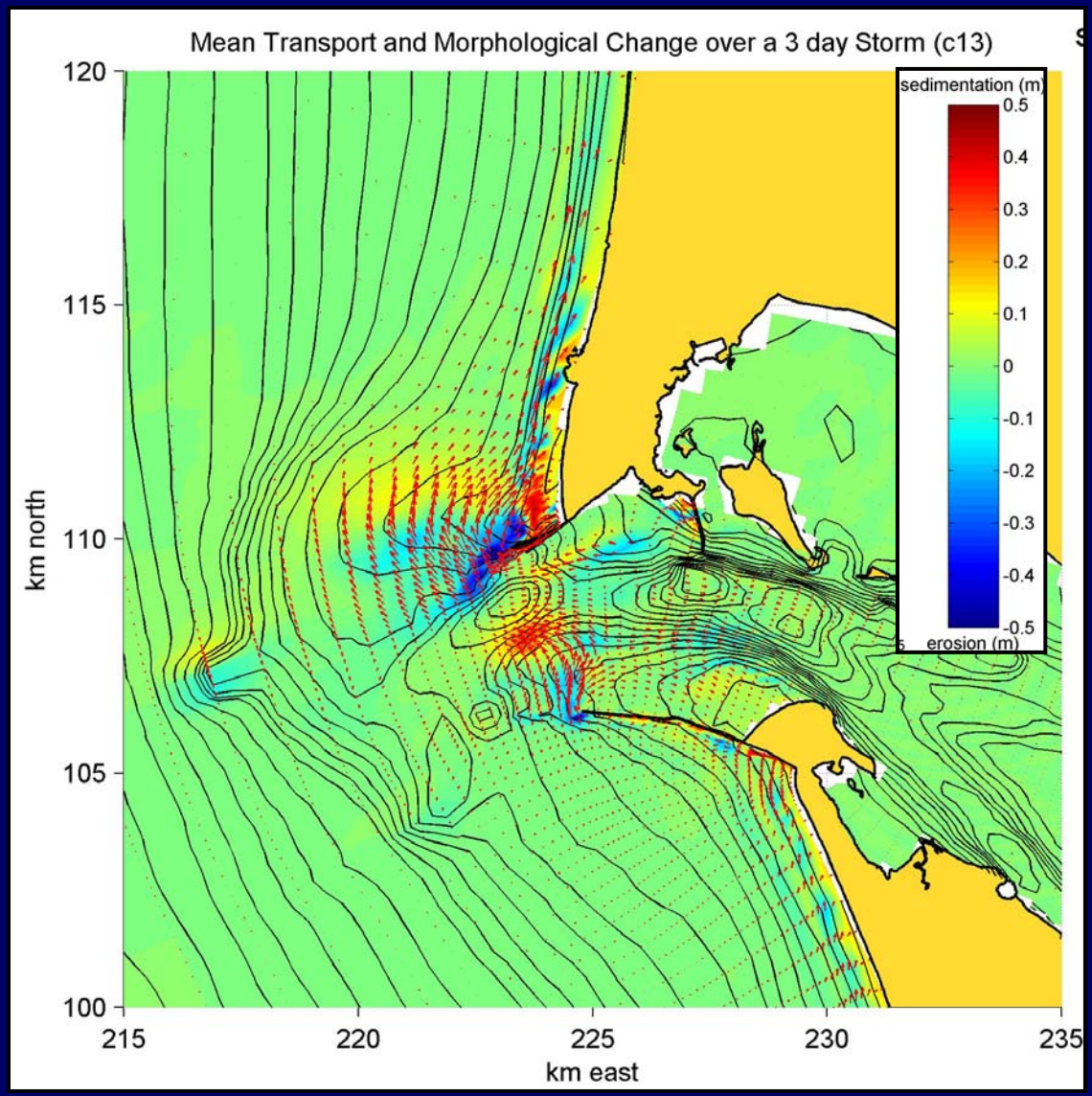


Factors controlling sediment transport

- Tides
- Waves
- Wind
- River discharge
- Estuarine circulation

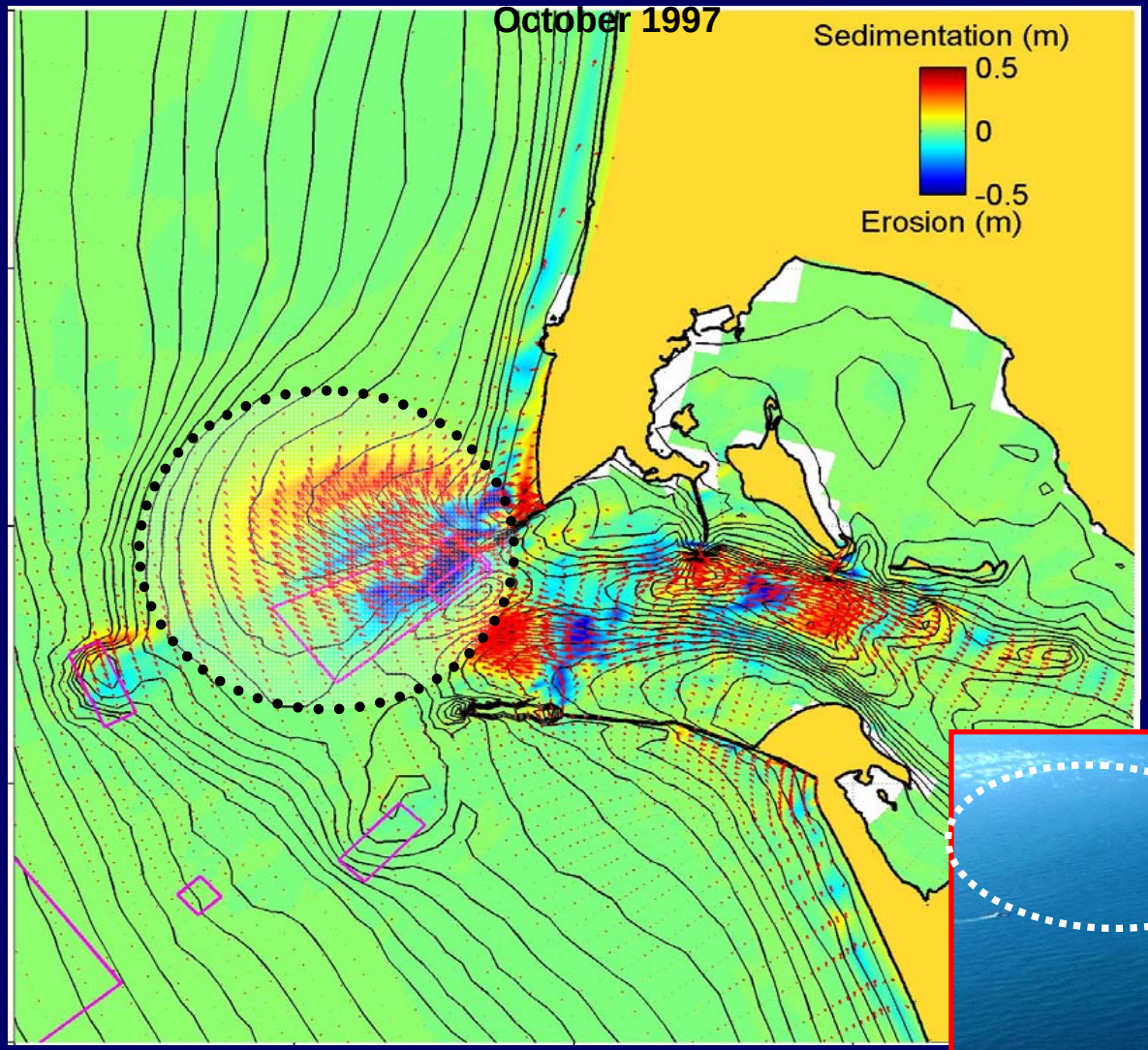


Net Sediment Transport, Erosion, and Deposition



- find dispersive areas
- maximize supply to littoral zone
- minimize re-handling
- minimize undercutting of jetties
- minimize disruption to biota
- Understand Processes

Net Sand Transport and Morphological Change during October 1997



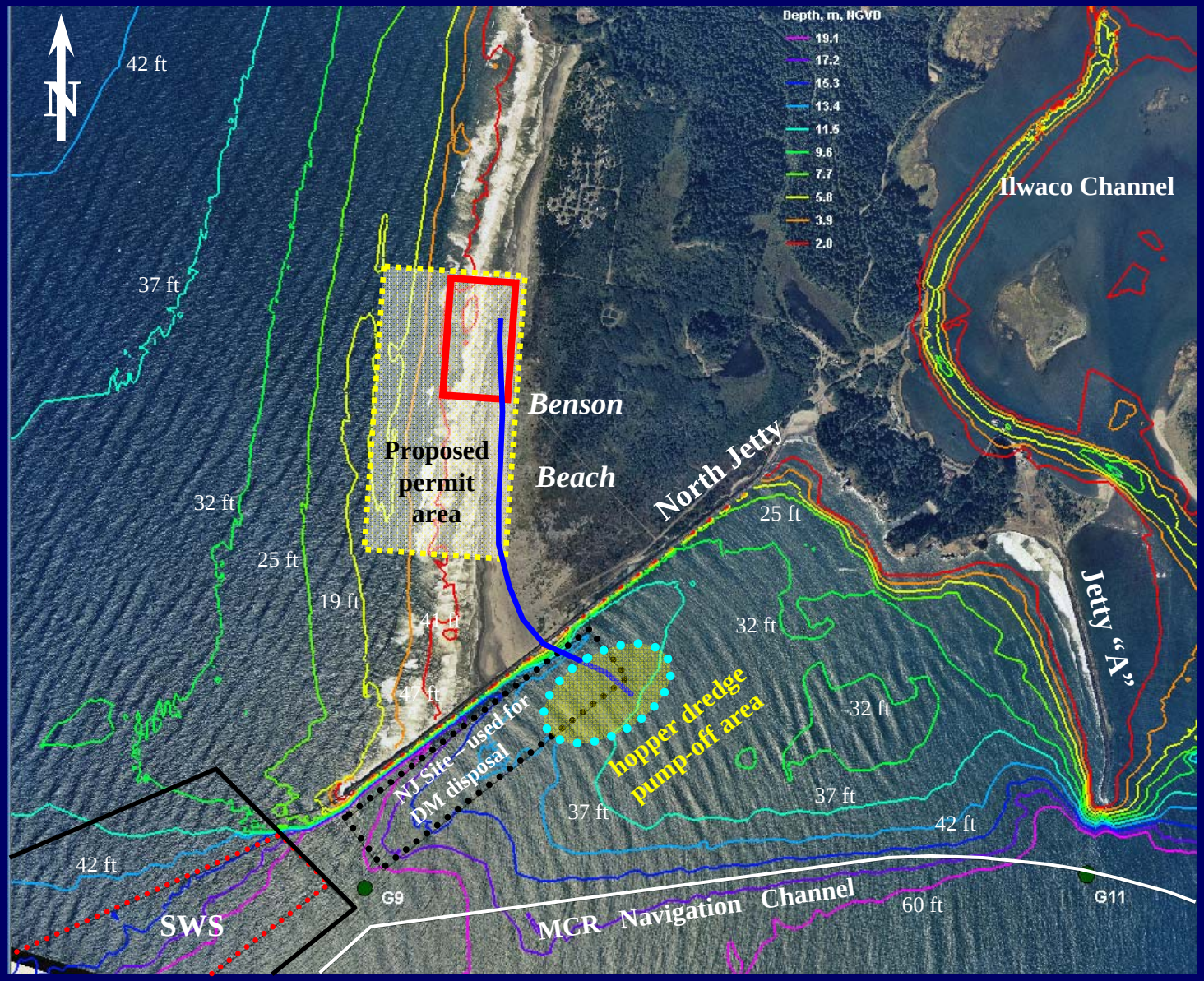
Process-based Morphological Modeling

- Sand transport at MCR is spatially and temporarily complex.
- A complex model is required to analyze and evaluate sand management alternatives.

RSM Situation Report

Consensus and Priorities

- Eliminate use of Deep Water Site.
- Implement specific Demonstration Projects.
- Monitor, model, test predictions, learn, adapt, optimize.



= Potential pump-ashore pipeline location

= Inter-tidal placement area for 500,000 cy

Contour data (ft NGVD) are based on 1999 -2003, contour elevations east of north jetty are approximate.

Mouth of the Columbia River - Bathymetry and 2007 Dredged Material Placement Sites

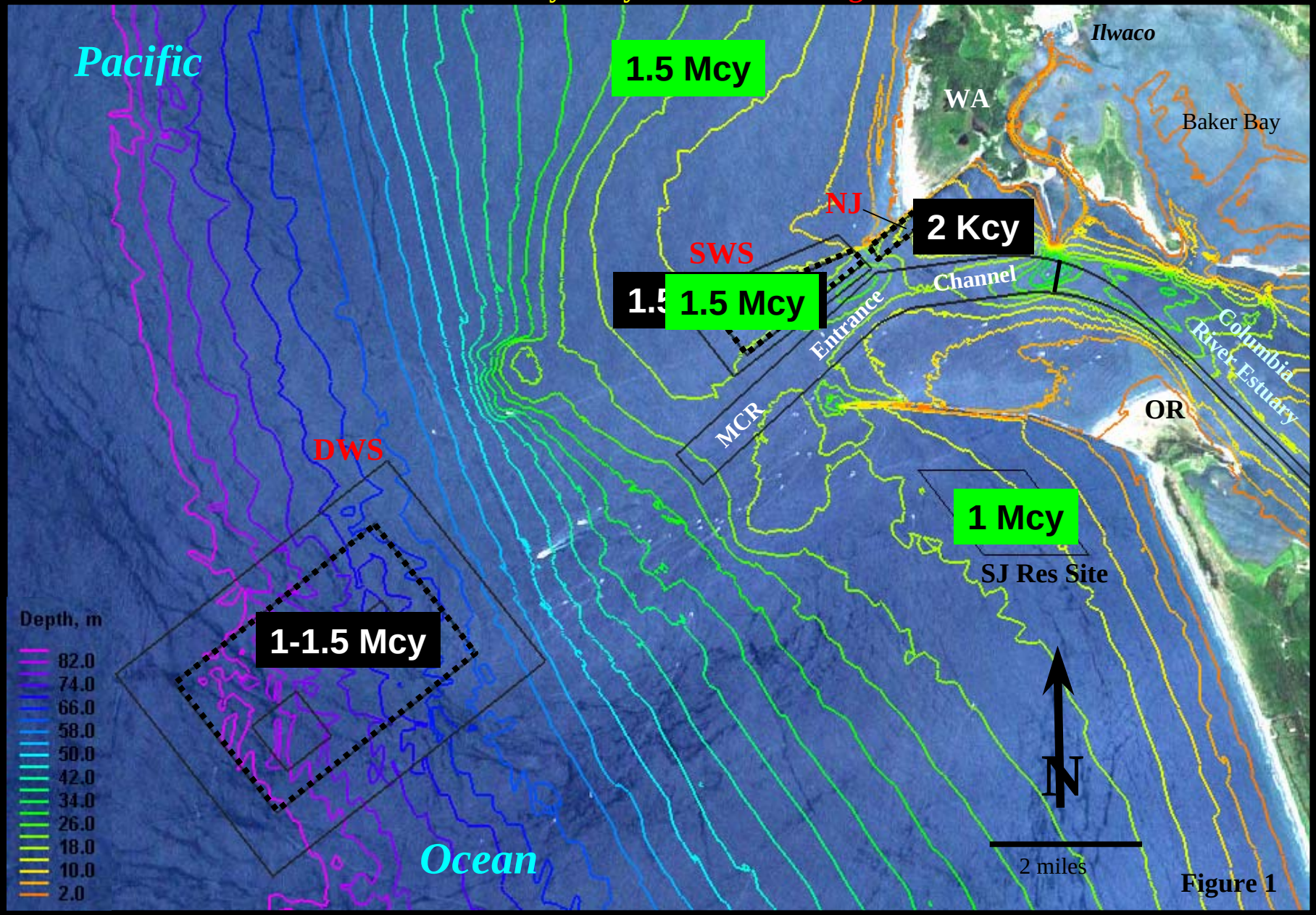


Figure 1

DWS= Deep Water Site, 102 MPRSA
SWS= Shallow Water Site, 102 MPRSA

NJ Site = North Jetty disposal site, 404 CWA

SJ Res. Site = South Jetty research site, restricted use by EPA permit

Challenges

- Minimize impacts to crab fishing industry.
- Minimize navigation hazards.
- Overcome “least cost” and incorporate life-cycle costs.
- Obtain authority and funding.

Solutions

- Cooperative and comprehensive team effort.
- Lower Columbia River and Estuary RSM.
- Develop project opportunities.
- Develop overall systems strategy.
- Empower USACE to do good.

Lower Columbia Solutions Group