

# Regional-scale understanding of the geologic character and sand resources of the Atlantic inner continental shelf, Maine to Virginia

Workshop on Dredging, Beach Nourishment and Bird Conservation  
Atlantic Coast, Maine to Virginia

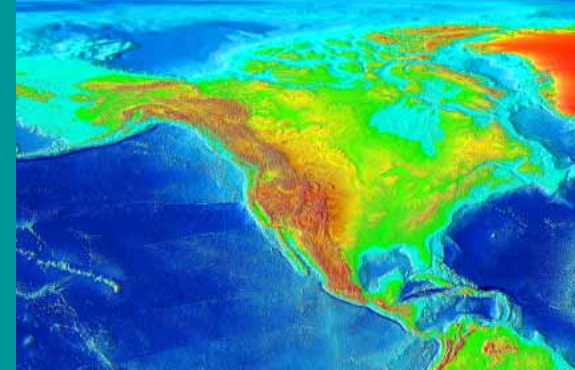
25 October 2005

*S. Jeffress Williams* ([jwilliams@usgs.gov](mailto:jwilliams@usgs.gov))  
U.S. Geological Survey  
Woods Hole, MA

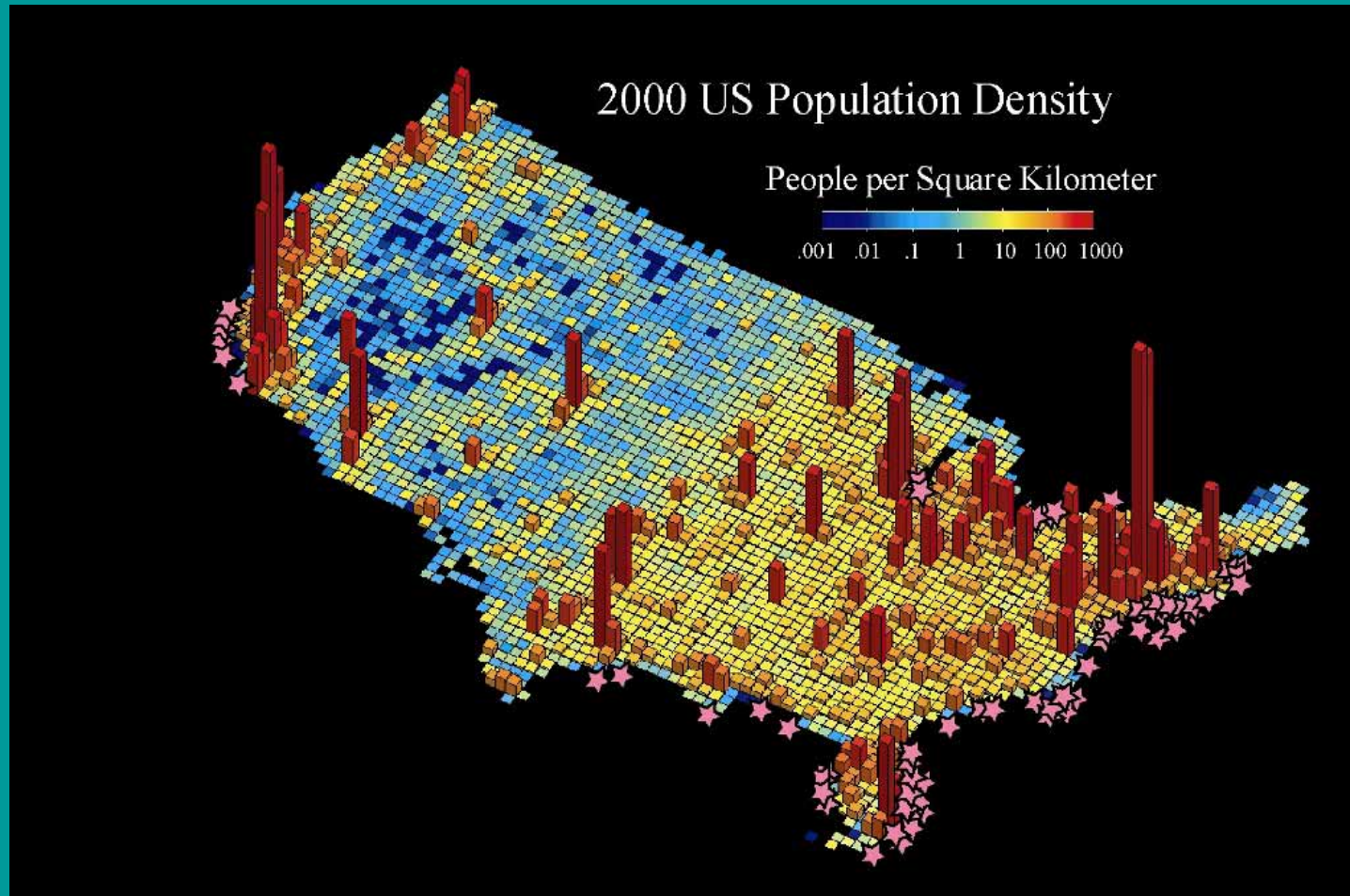
# Factors and Processes Driving Coastal & Inner Shelf Change

- ❖ **Geologic framework and character**
- ❖ **Geomorphology/coastal plain slope**
- ❖ **Relative sea-level change**
  - eustatic/global change
  - land subsidence/uplift
- ❖ **Major storm events**
  - tropical storms/ hurricanes
  - nor'easter storms
- ❖ **Routine coastal processes**
  - waves
  - tidal currents
  - winds
- ❖ **Coastal/inner shelf sediment budgets**
  - sediment sources (headlands)
  - sediment sinks (washover, inlets)
- ❖ **Human activities**
  - coastal engineering
  - dredging channels & canals
  - oil-gas-water extraction
  - climate change

# Need for seafloor sediment maps and sand resource assessments



- ❖ **>70% of US coasts undergoing long-term chronic erosion.**
- ❖ **Coastal development, population and recreation continue to increase for all coastal regions.**
- ❖ **Global climate change is likely to increase storminess and accelerate sea level rise, resulting in increased coastal vulnerability to erosion and flooding hazards.**
- ❖ **Beach nourishment is increasingly the preferred method of mitigating coastal erosion and restoring ecosystems.**
- ❖ **Large volumes of high quality sand are required for nourishment, on-land resources are limited, and marine sand bodies on inner shelf regions are increasingly attractive targets.**
- ❖ **The geologic character of marine sand bodies is highly variable resulting from dynamic marine transgression processes over the past ~20k years.**



Map showing population density and 70 large USACE beach erosion projects. The highest population is along the coast, concentrated in major metropolitan centers. In 2000, ~150 M people (53%) lived in coastal counties which occupy just 17% of the US land area.

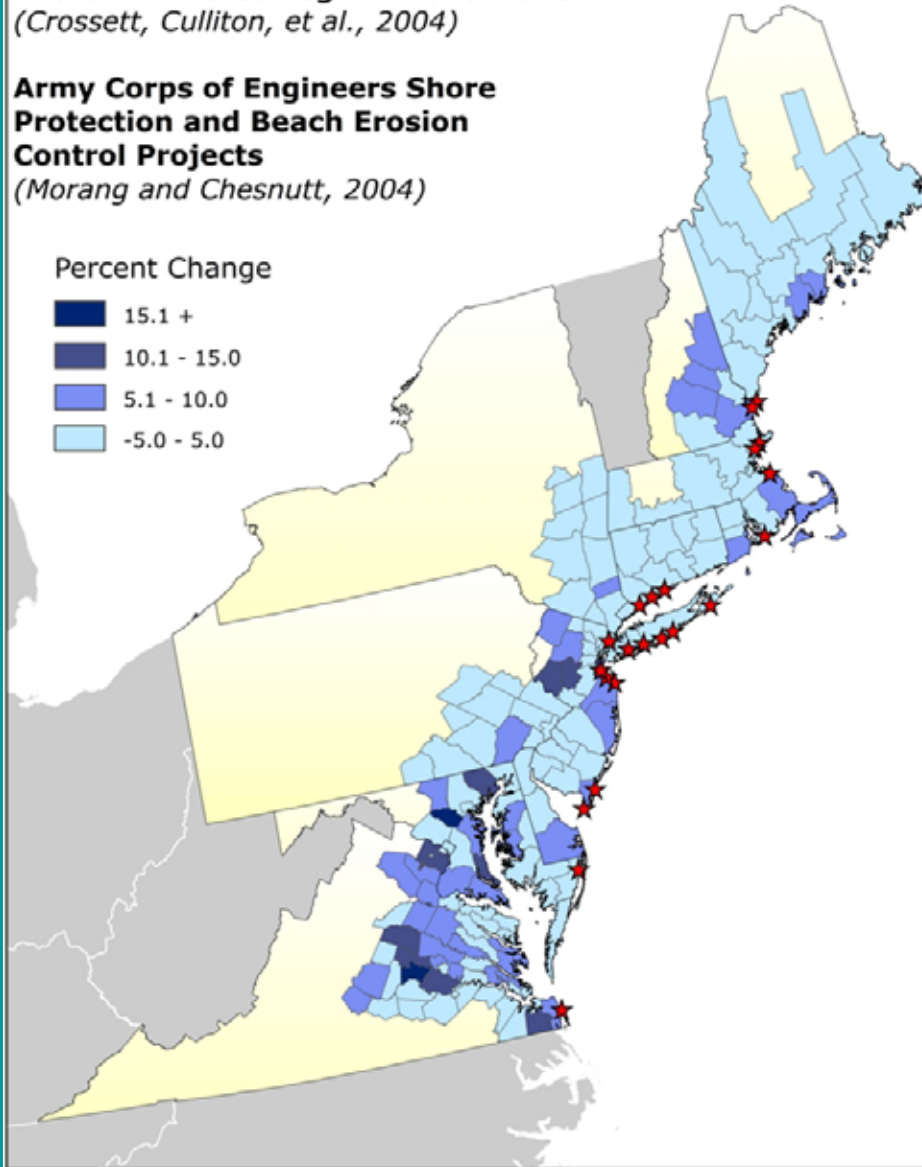
**Projected Percent Population Change by County  
in the Northeast Region: 2003-2008**

*(Crossett, Culliton, et al., 2004)*

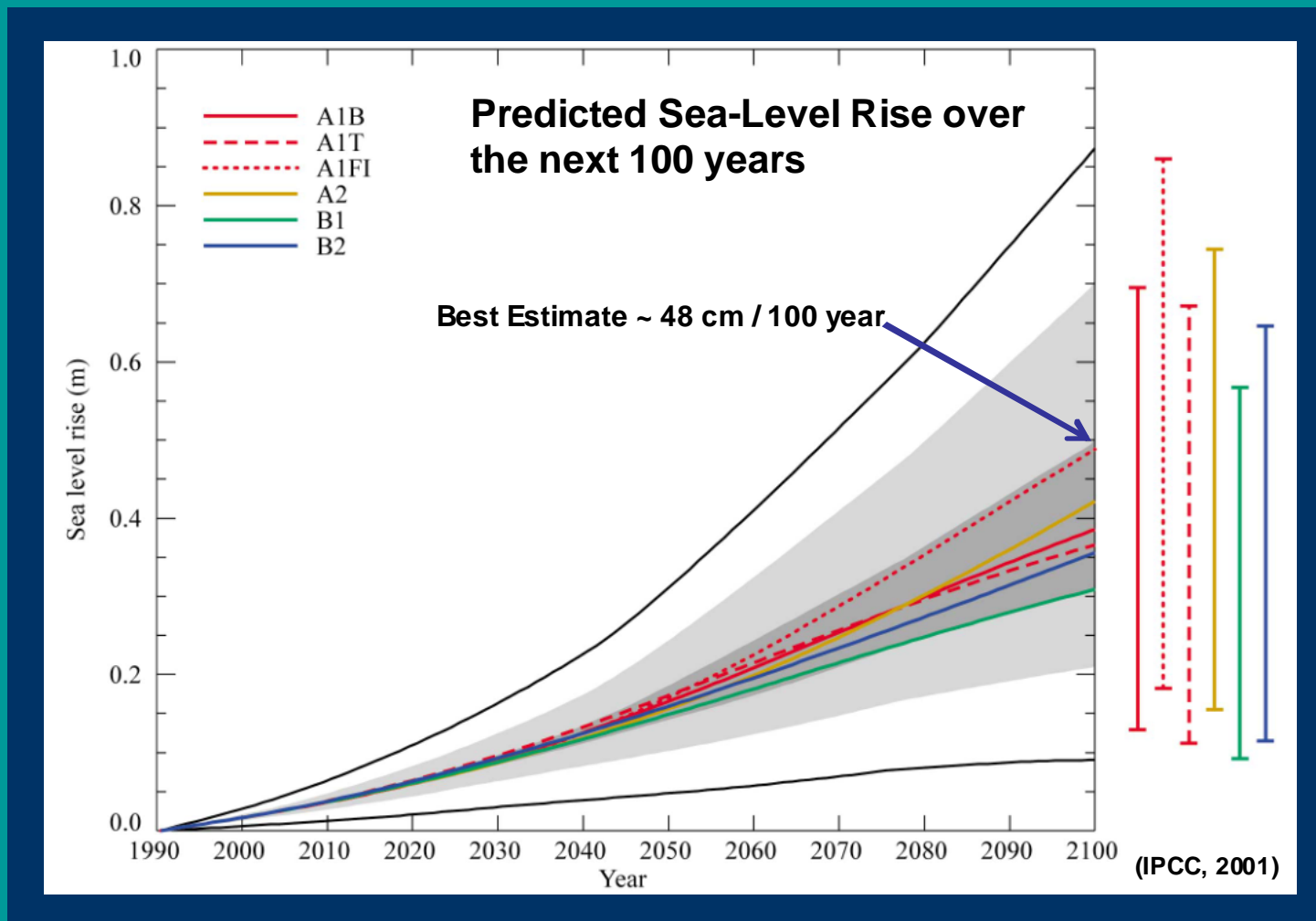
**Army Corps of Engineers Shore  
Protection and Beach Erosion  
Control Projects**

*(Morang and Chesnutt, 2004)*

Percent Change



# Motivation for sea-level rise research



# The Coast of the Future

- ❖ Predicted rise in global sea level of ~48cm by 2100 will have profound effects: inundate coastal margins, increase loss of wetlands, increase coastal hazards.
- ❖ Barrier islands, deltas, low-lying coasts and coastal cities will be at greater risk from flooding, coastal erosion, and more storm activity.
- ❖ Ocean salt water will intrude farther into estuaries and coastal aquifers, affecting wetland habitats and fresh-water aquifers.
- ❖ The Gulf and Atlantic coasts are most vulnerable. Higher elevation rocky New England and Pacific coasts may see fewer impacts.
- ❖ Use of coastal setbacks, easements, soft engineering, restoration of natural processes can sustain shoreline integrity and public resources.



Offshore dredge used to pump sand for beach nourishment



Surfside Beach, South Carolina before nourishment



Surfside Beach, South Carolina after nourishment

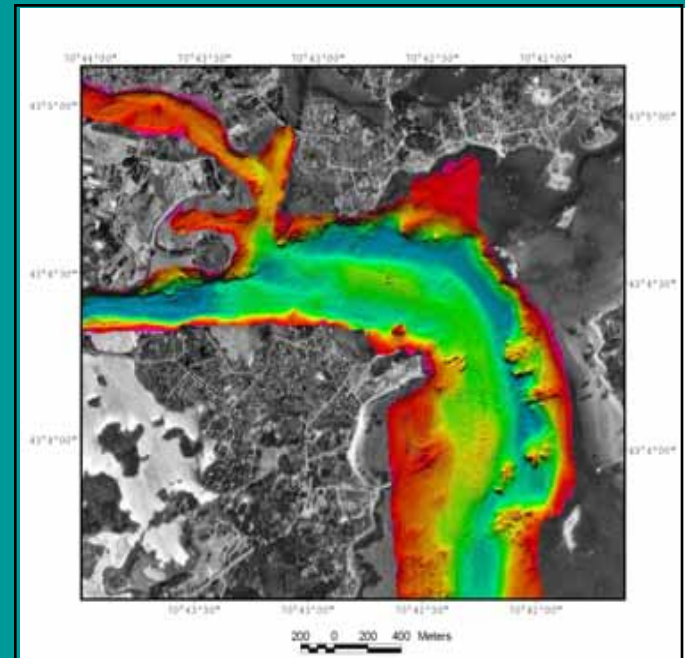
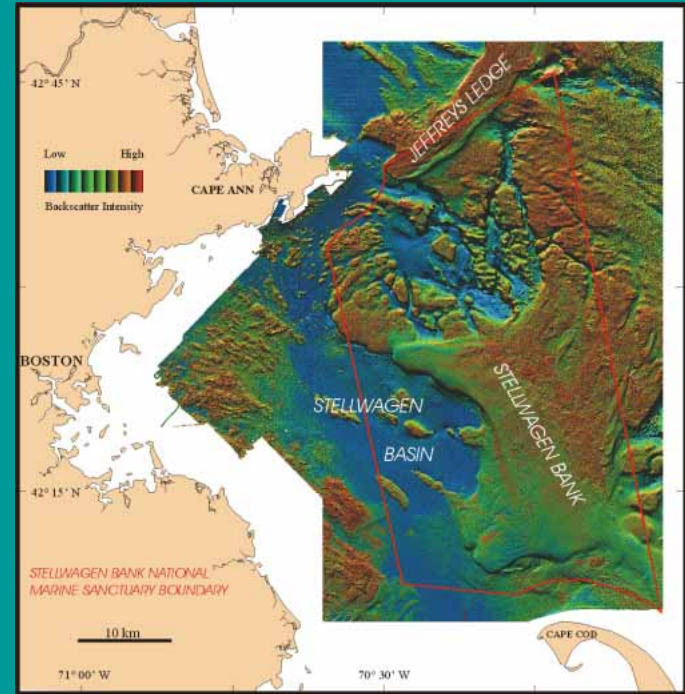
## Offshore Sand for Beach Nourishment

- Nourishment in the U.S. started in the 1920's (New York, Hawaii)
- Has become the preferred method for erosion control and storm protection
- Approximately 200 projects in U.S., 642M m<sup>3</sup> of sand dredged and pumped on beaches
- Demand for sand likely to increase with more coastal development, more human impacts, increased sea-level rise, increased storm erosion
- For many U.S. regions, offshore sand resources are limited by geology, environmental concerns, and lack of sand resource information



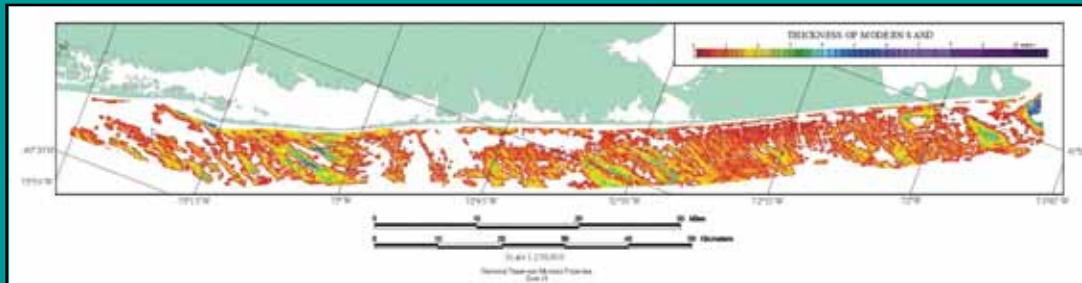
Offshore regions are complex and heterogeneous. Accurate base maps are critical for wise planning and management of marine resources

Swath mapping technology is revolutionizing geoscience research when integrated with other tools such as seismic, sidescan sonar, GIS, and usSEABED sediment data base

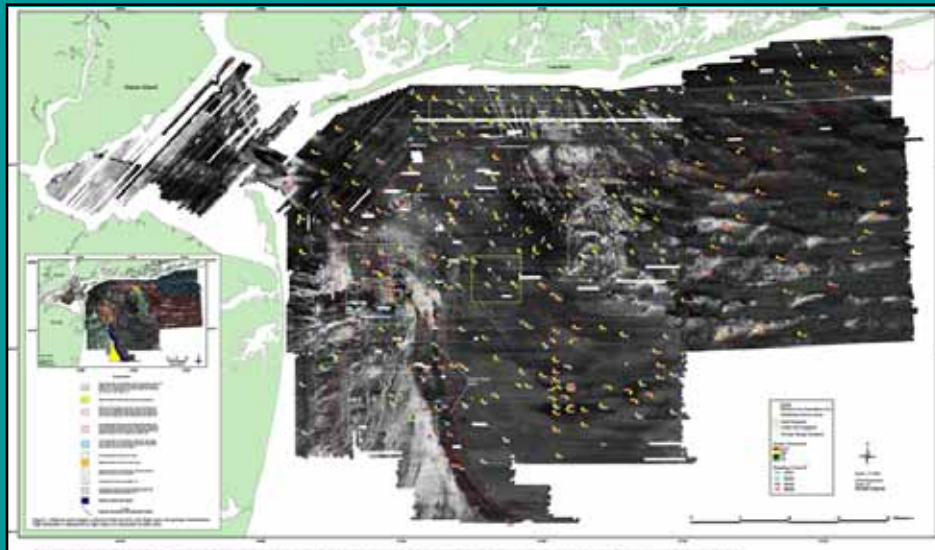


# USGS Applications of Sea Floor Mapping

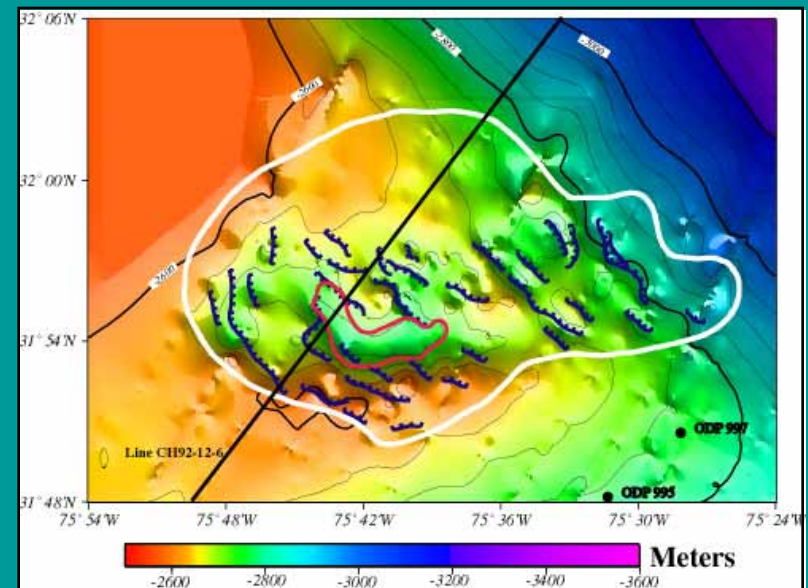
Coastal  
Erosion/Climate  
Change (Hazards)



Nearshore  
Sediment  
Distribution and  
Dynamics  
(Resources)



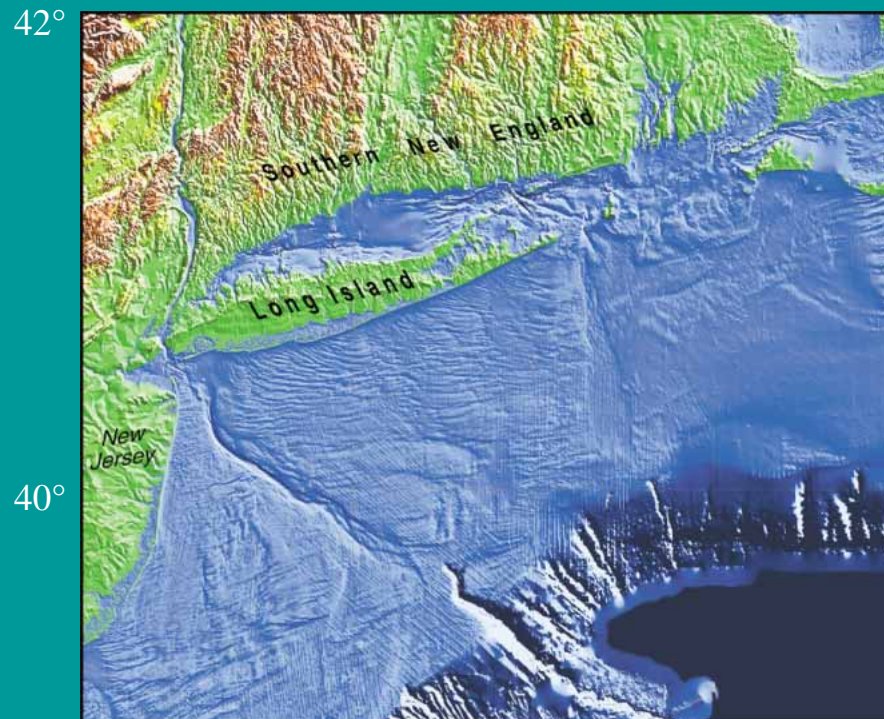
Sediment Contamination (Environment)



Gas Hydrates (Hazards/Resources)

## New York Regional Studies

*Cost-shared with U.S. Army Corps of Engineers,  
New York District*



74°

(From Uchupi et al., 2001)

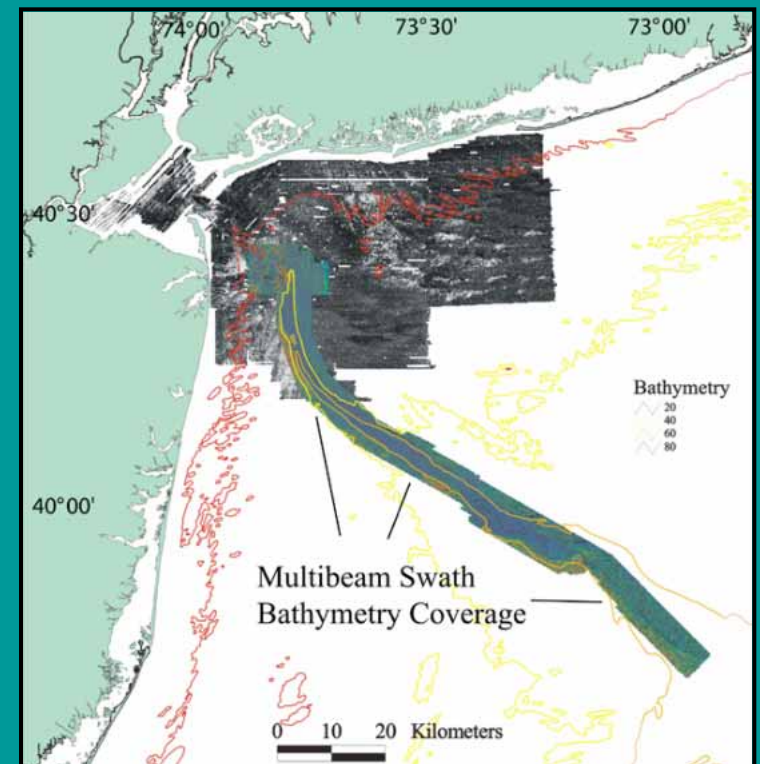
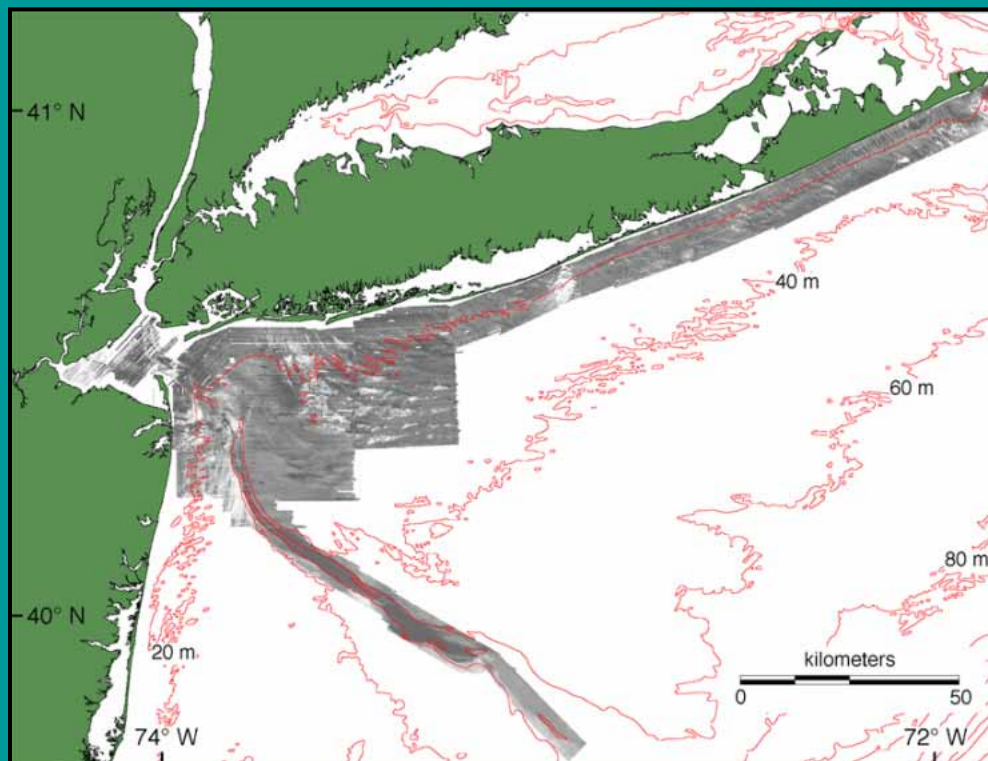
70°

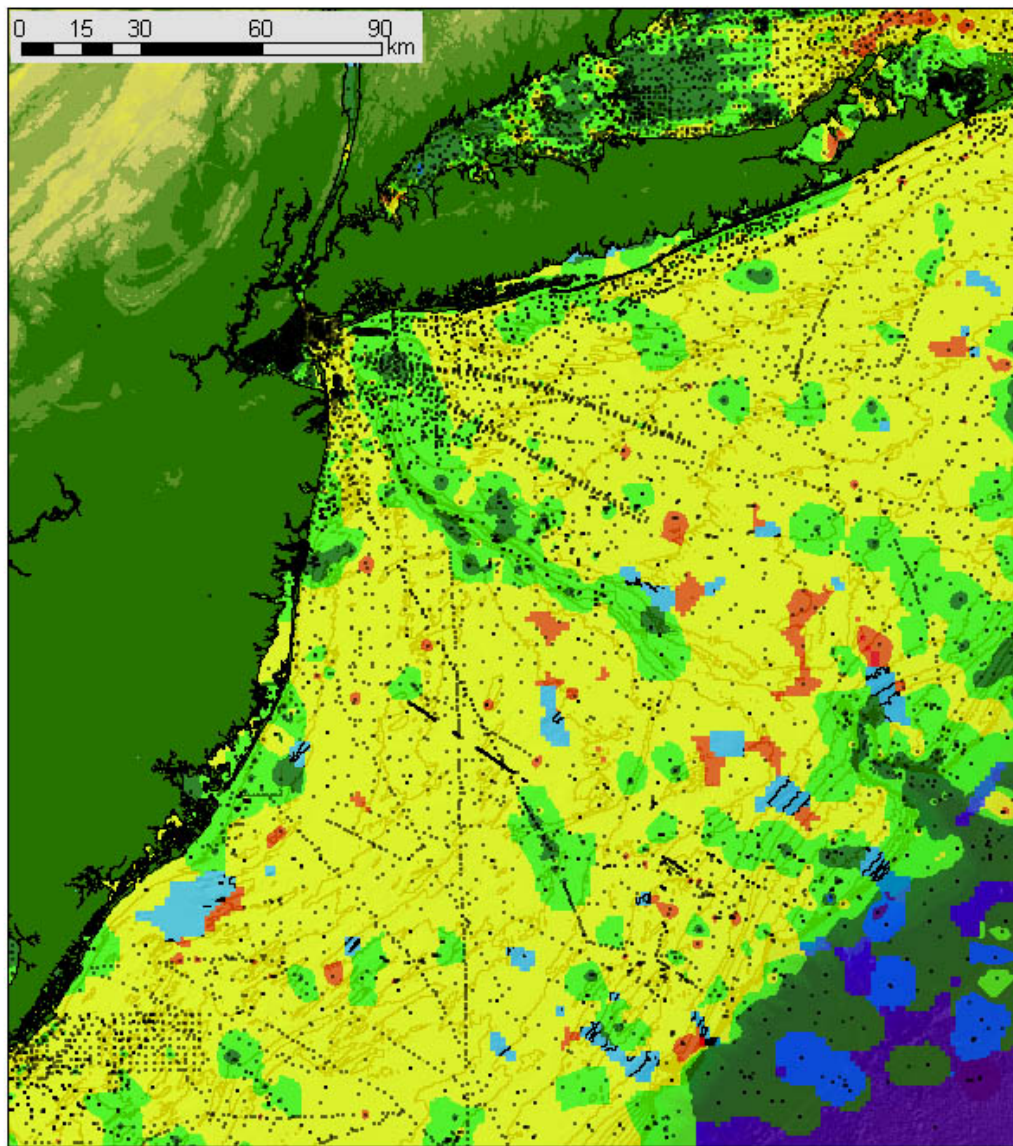
Regional environmental  
impact of waste disposal

Provide baseline information  
for planning for offshore  
disposal of dredge materials

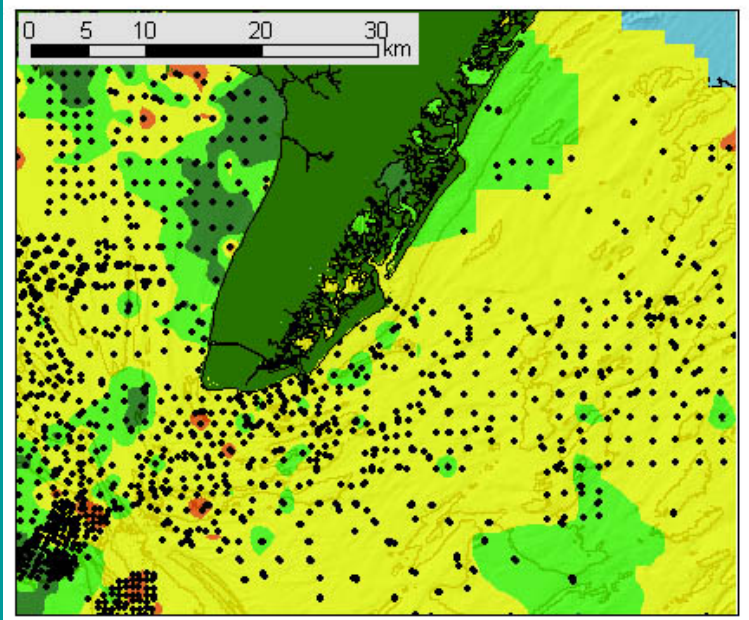
Re-assessment of regional  
aggregate resources needed  
for coastal nourishment

# Study Area Was Mapped Using Side-scan Sonar, Multibeam Echosounder, Seismic, and Sediment Sampling Techniques



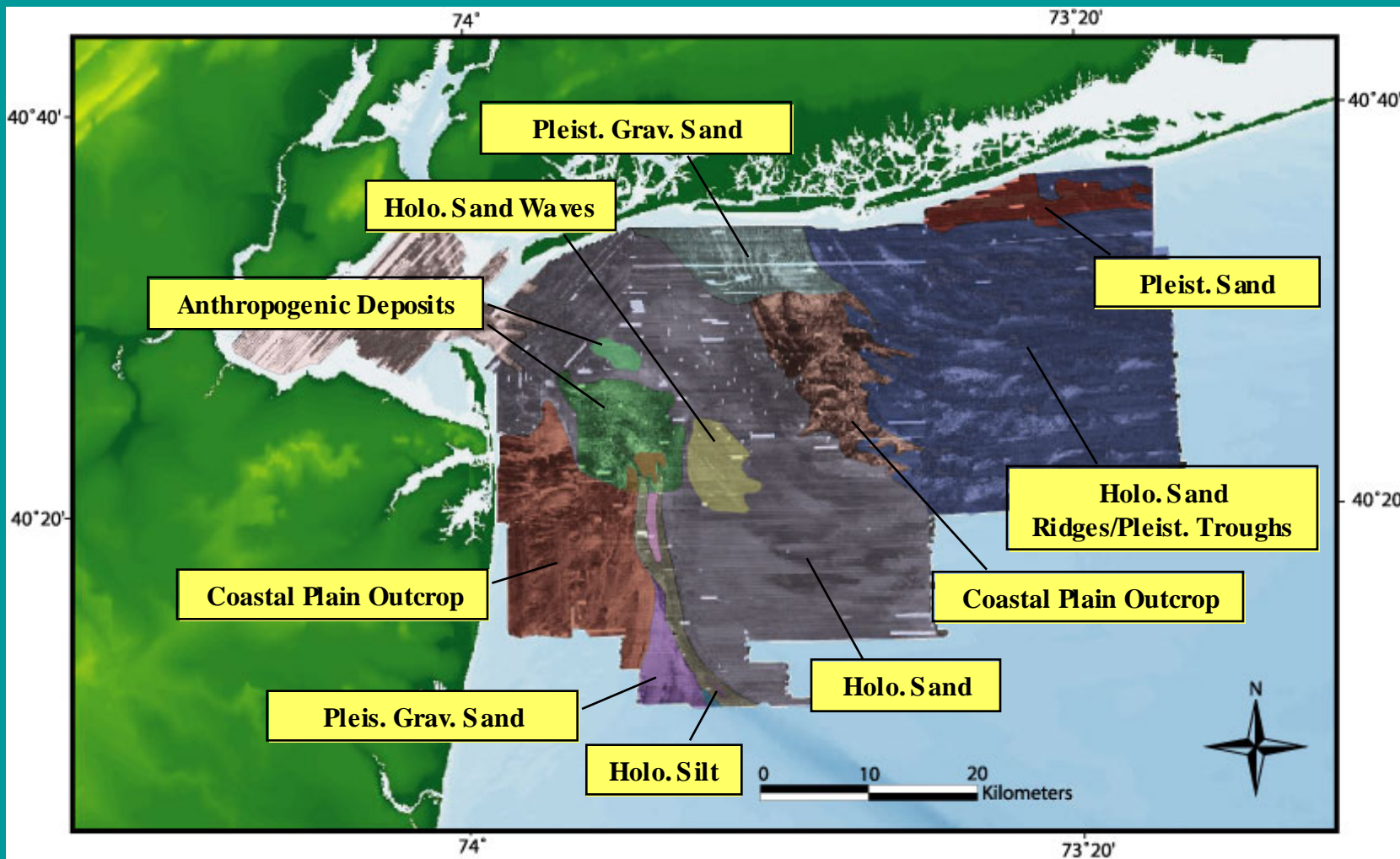


Fixed radius interpolation using IDW, radius = 6 km, no. of samples = 24,133



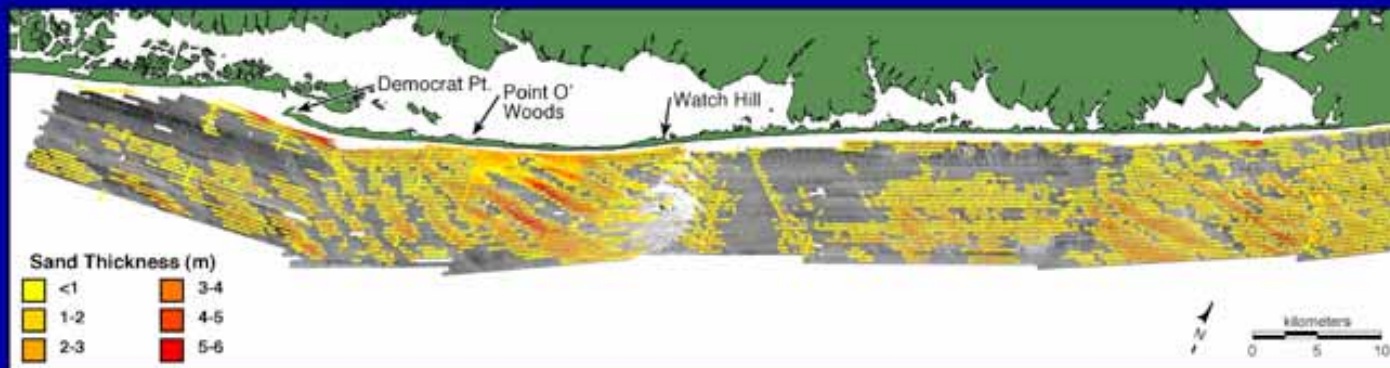
## Grid maps of seafloor sediment texture offshore NY and NJ

# Seabed Interpretive Map



## Distribution of Holocene Sediment:

Sediment Distribution Defines Paleo-Barrier-Island System



# Marine Aggregate Resources and Processes

## Project rationale and directions-

A direct response to *Science for Decision Making*, NRC (1999), Grand Challenge 1, Establish the geologic framework of US coastal & marine regions....need to integrate existing info into national assessments... the distribution and quality of marine mineral resources.

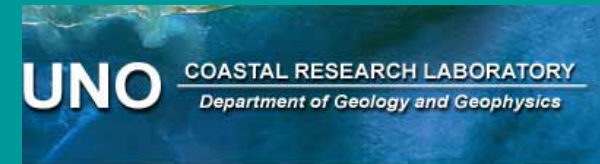
Federal (MMS, USACE, NOAA, EPA), coastal state and local regulatory agencies need marine science information for managing coastal resources, planning and decision making.

The USGS is the principal federal science mapping agency for interpreting and describing the geologic framework and character of US continental margins and for providing information on availability of mineral resources within the EEZ.

Project, in collaboration with others, is carrying out a series of regional-scale studies of the shelf sedimentary character and associated sand and gravel resources.

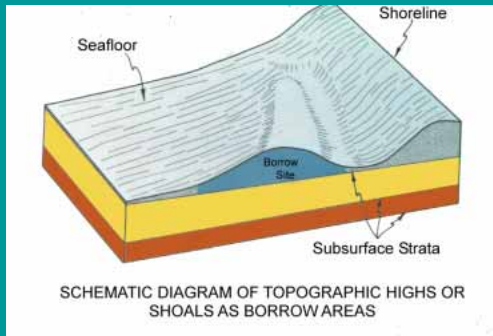
The regional studies comprise a suite of reports, maps, data bases of seafloor sediment character, resulting in an integrated national assessment of potential offshore sand and gravel resources.

Reports, maps and assessments provide information and guidance to federal and state agencies having resource and seafloor regulatory and management responsibilities.





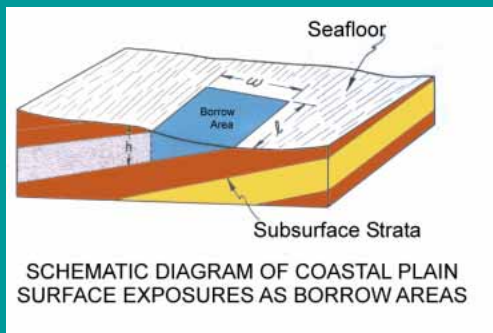
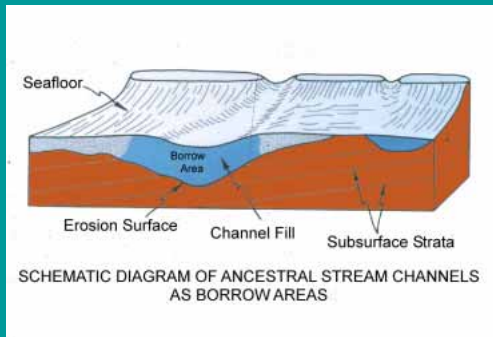
# Marine Aggregate Resources and Processes



*A Partnership of USGS, ONR, NOAA, MMS, USACE, States and Academia to Characterise the Nation's Seafloor Sedimentary Character and Assess Aggregate Resources*

## Themes

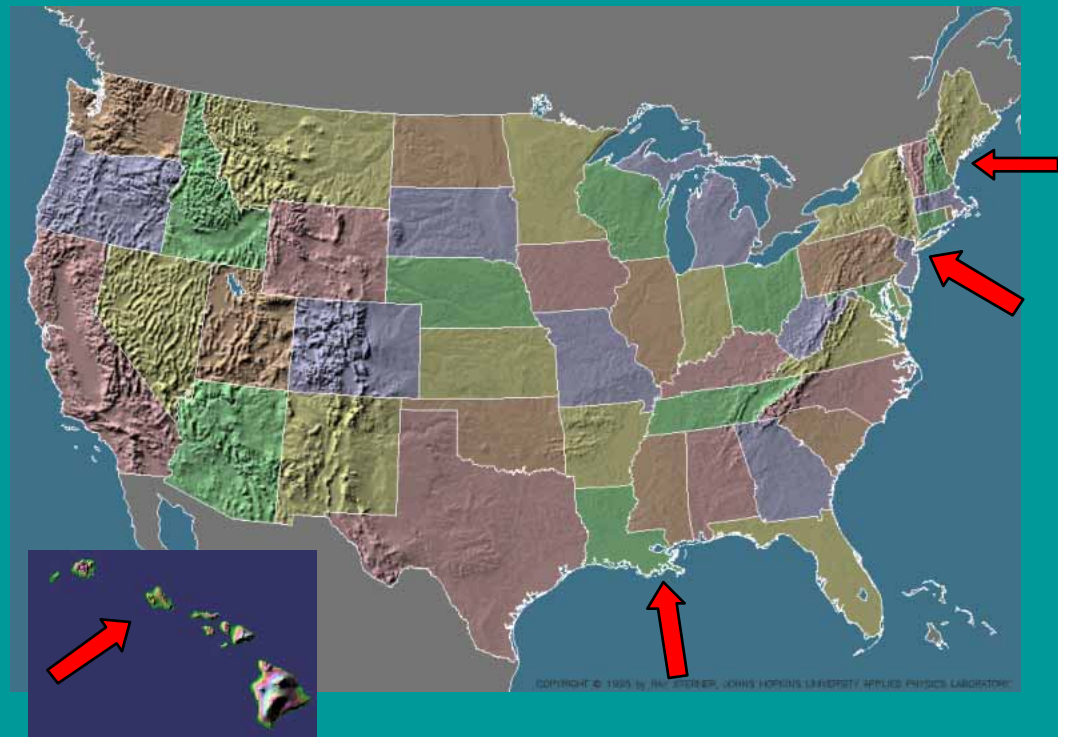
- Scientific evaluation and synthesis of available maps and reports (published, gray literature, files)
- Compilation and integration of legacy marine geologic data into usSEABED database system
- Scientific interpretation of shelf history and processes, marine sand body origins and evolution
- Reports, GIS digital map products and usSEABED data available on internet and in publications

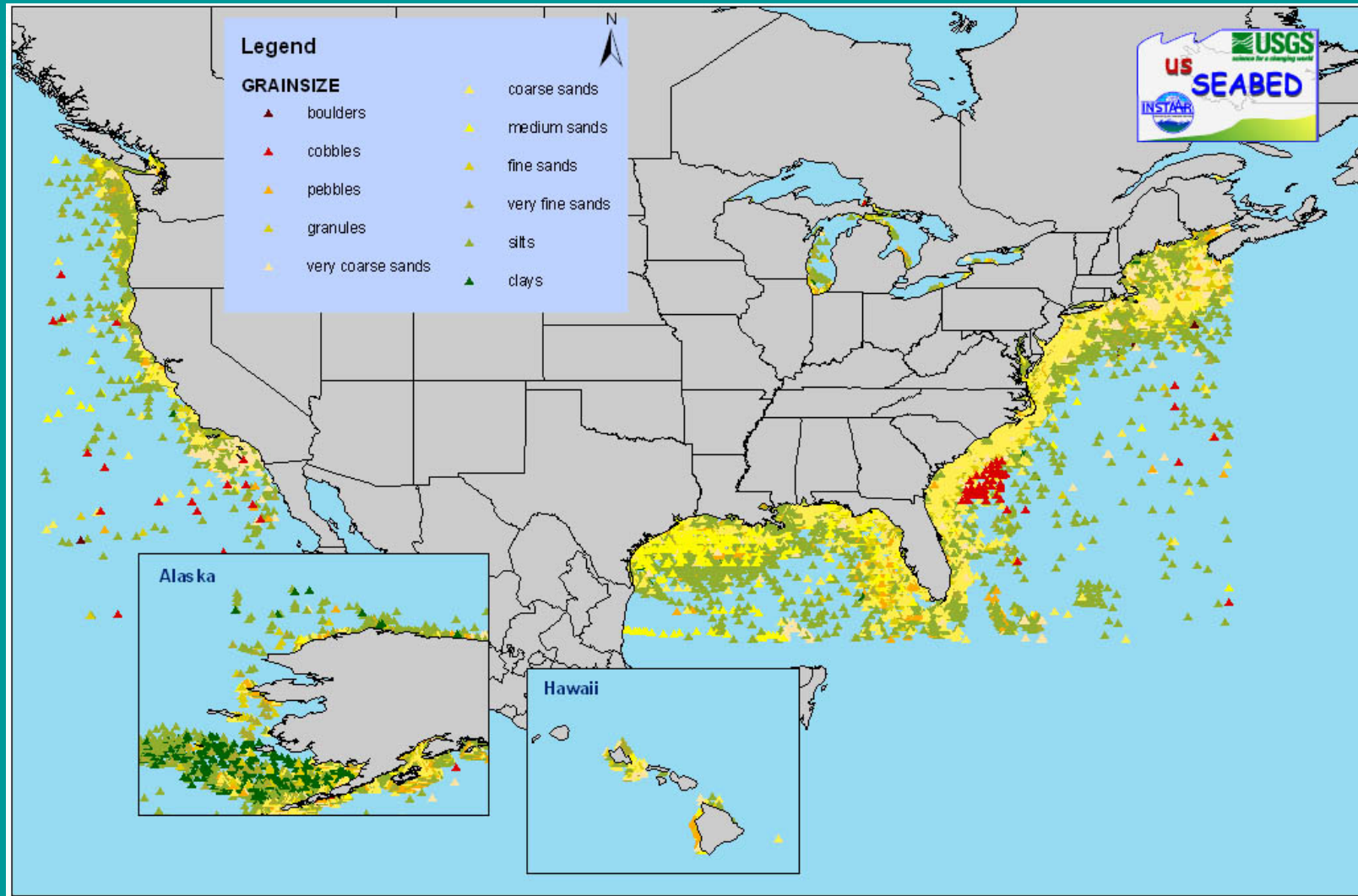


# Marine Aggregate Resources and Processes

## Project Tasks

- ❖ Regional assessment for New York & New Jersey
- ❖ Regional assessment for Louisiana
- ❖ Regional assessment for Gulf of Maine
- ❖ Development of usSEABED as a national GIS system for seafloor sedimentary character





**Map of usSEABED data coverage in US EEZ showing seafloor sediment texture**

## Summary



*Shorelines and coastal development will be even more vulnerable to hazards in the future. Need for offshore sand for nourishment will increase. Sand volumes for sustainable shore protection are uncertain for many regions.*

*Geologic framework influences shelf sediment character, distribution, and shelf physiography.*

*Sediment processes acting on the inner shelf influence the evolution of the shelf and adjacent coast.*

*Better understanding of the shelf geology can aid our ability to predict future coastal change and to plan for sustainable use of coastal regions.*