

California Seafloor Mapping Project: Progress report on a collaborative approach

Rikk Kvitek

CSUMB Seafloor Mapping Lab

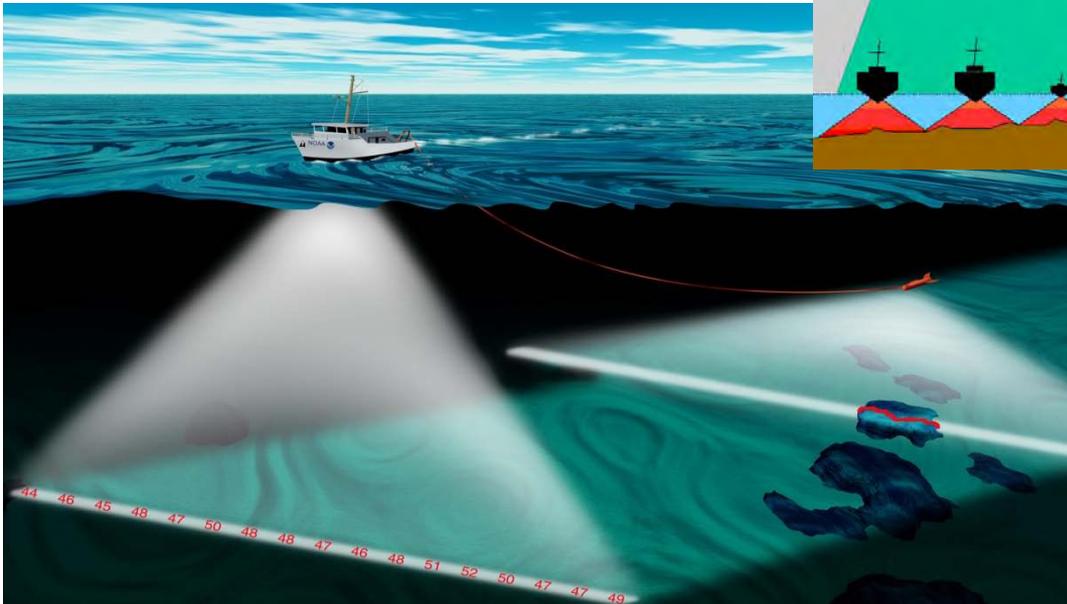
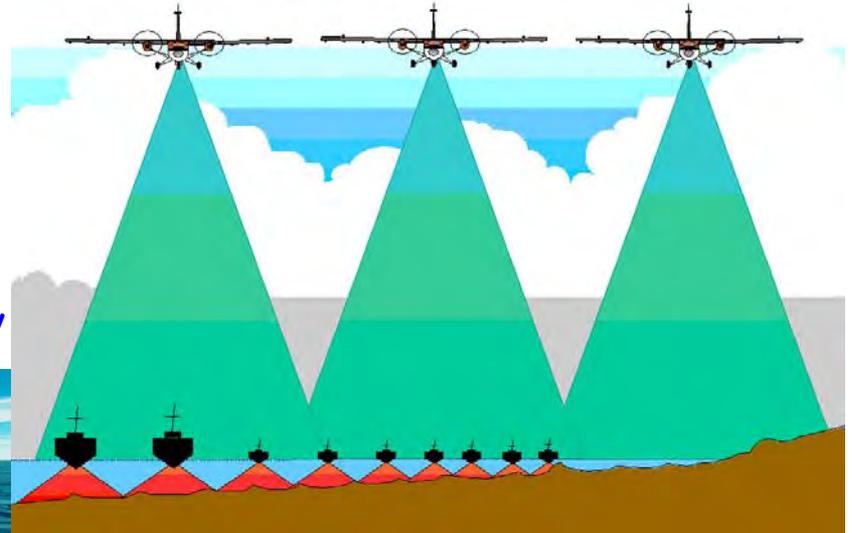
Guy Cochran – USGS

Edward Saade – Fugro Pelagos, Inc.

Gary Greene – Moss Landing Marine Labs

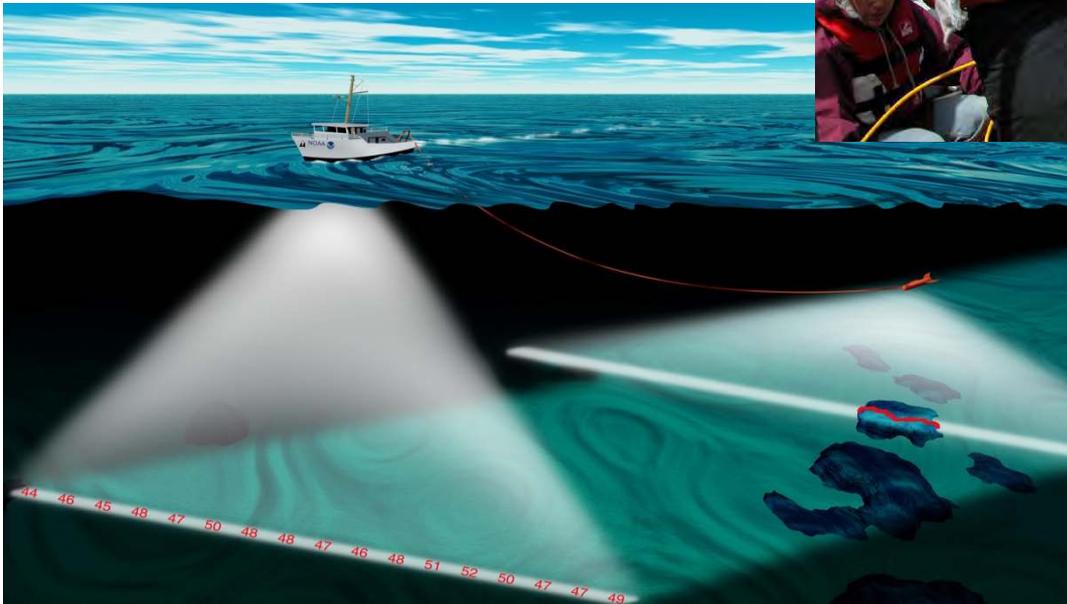
Chris Wills – California Geological Survey

Sheila Semans – California Coastal Conservancy





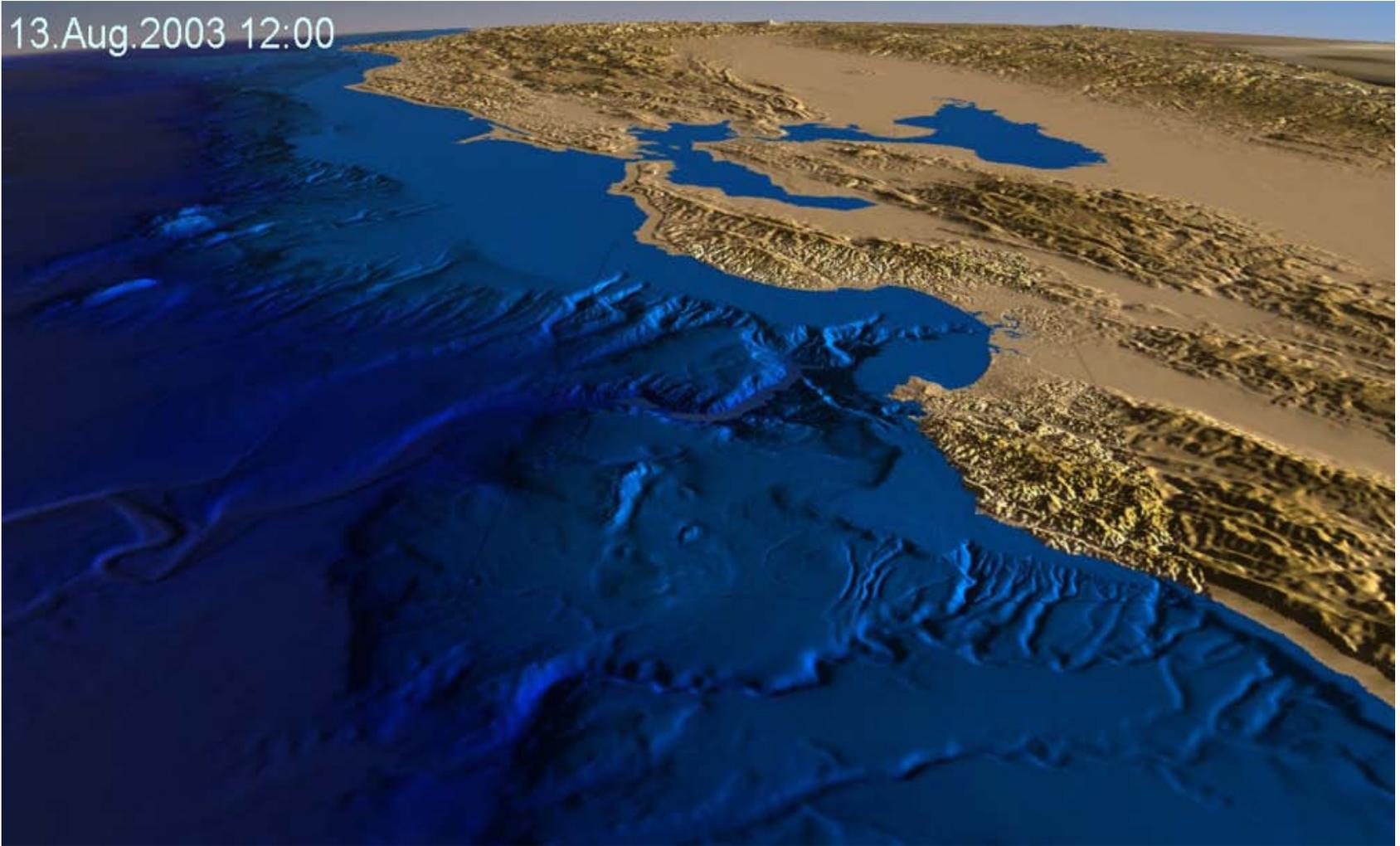
Rikk Kvitek – Division of Science & Environmental Policy
California State University, Monterey Bay



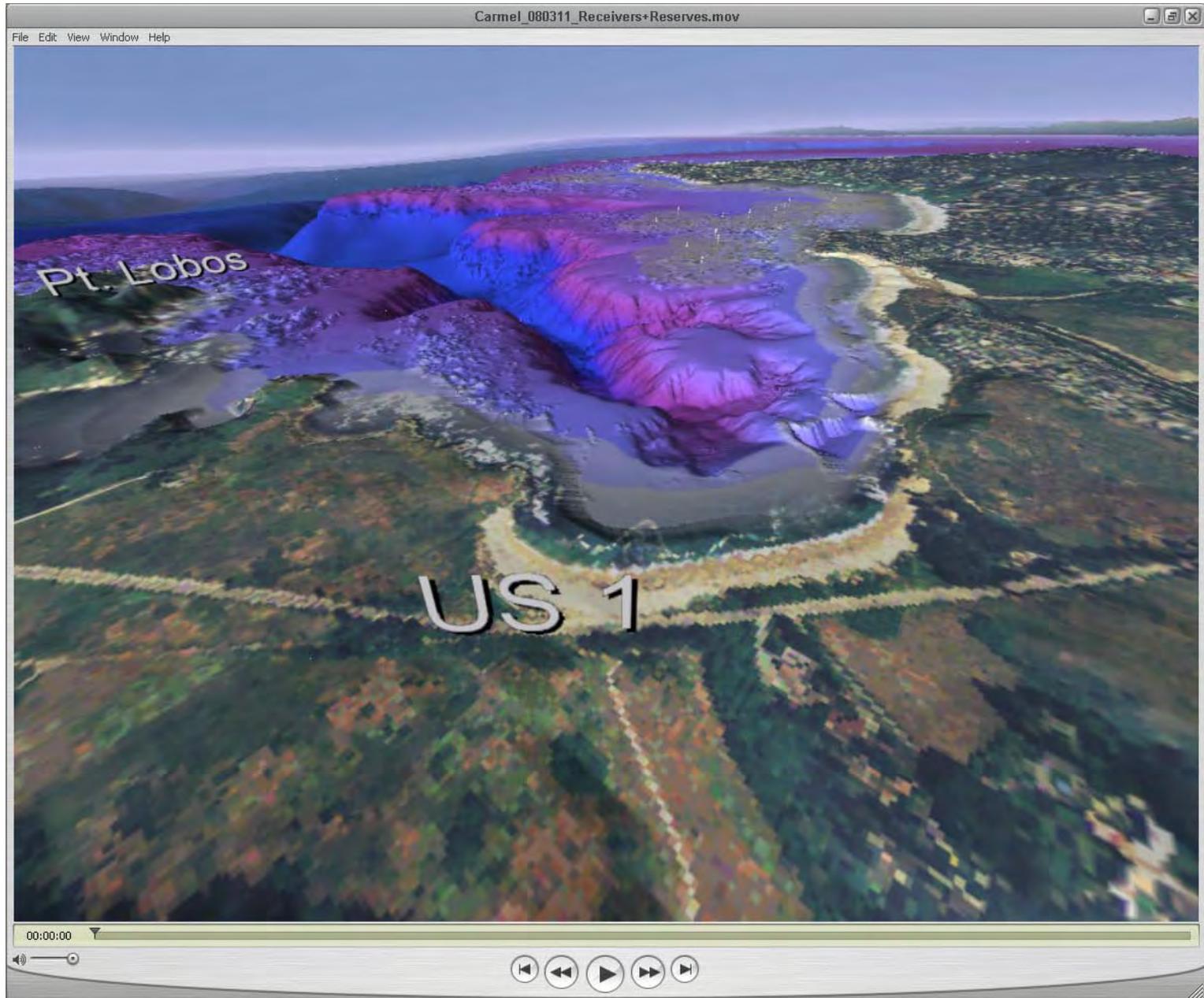
**Student-Powered Research
Promotes
Hands-on-Learning
In
Geospatial Technology**

Eco-forecasting: The Future of Coast Ocean Monitoring

13.Aug.2003 12:00

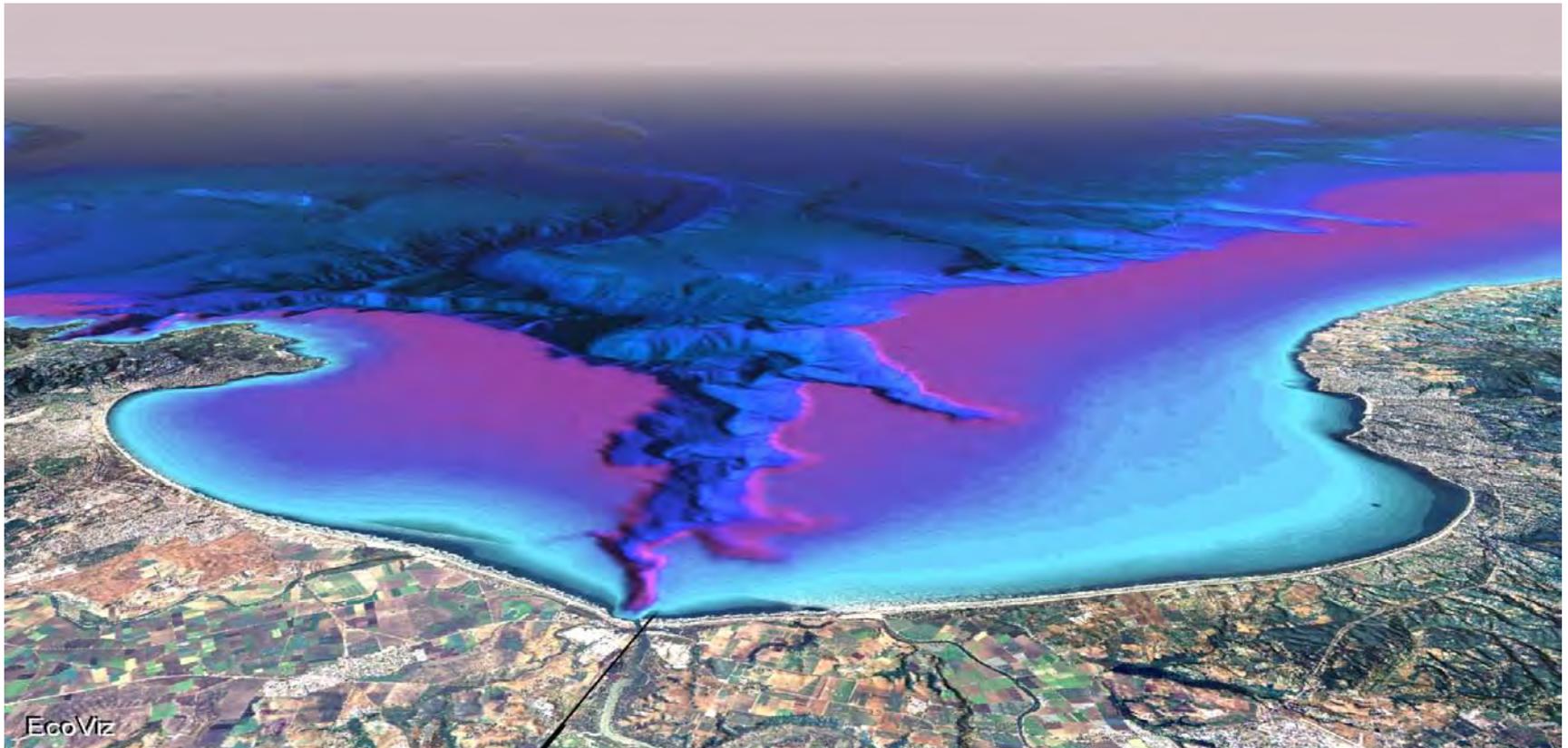


The Near Future – Ecosystem Dynamics Visualization



Creating the Foundation

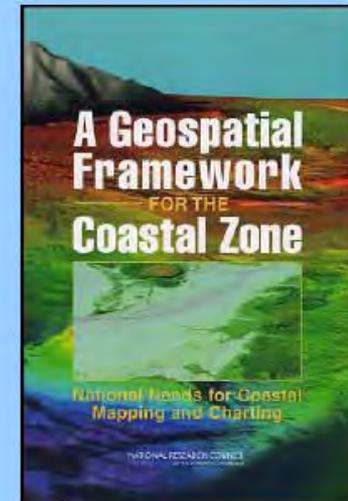
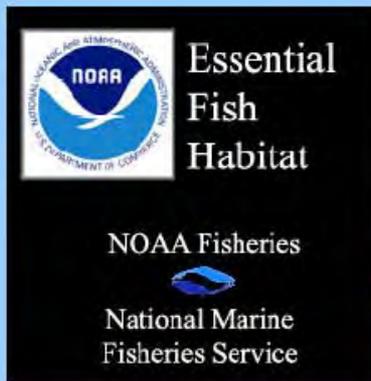
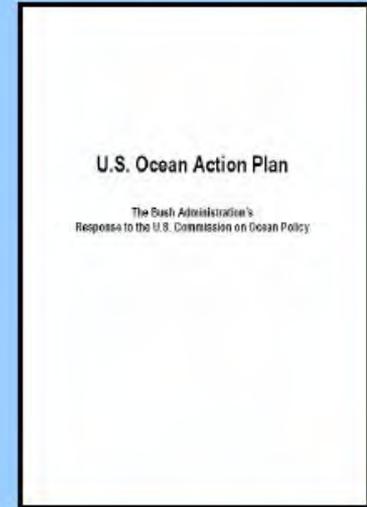
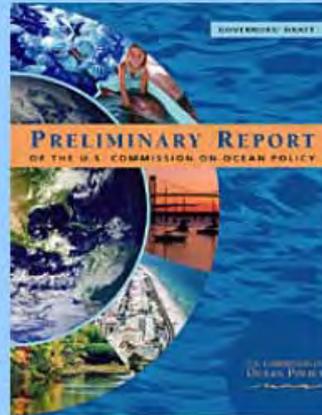
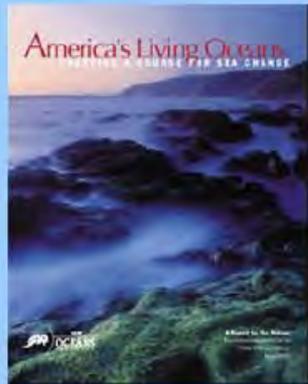
California Seafloor Mapping – what made it happen?



Federal Ocean Commission Reports Recommending Ecosystem-Based Management



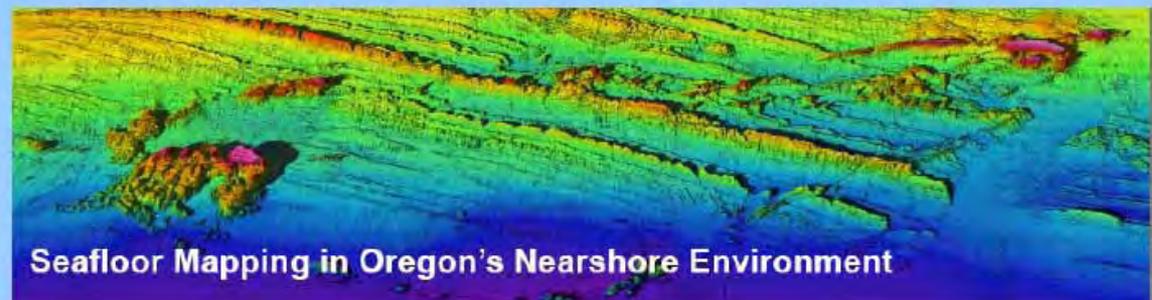
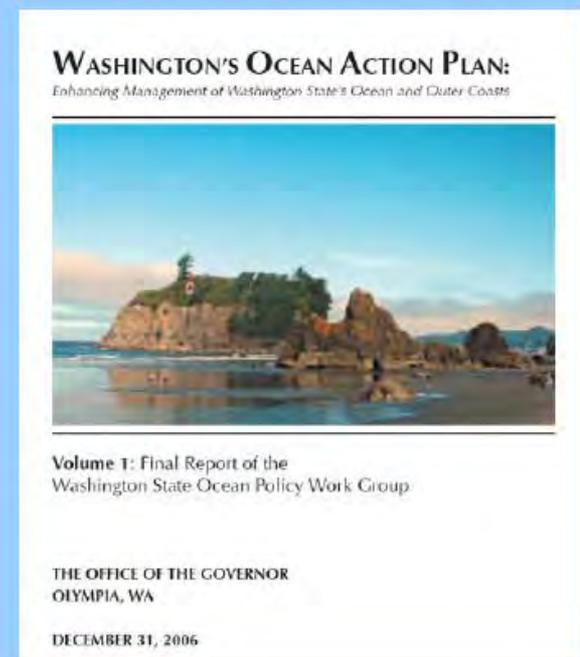
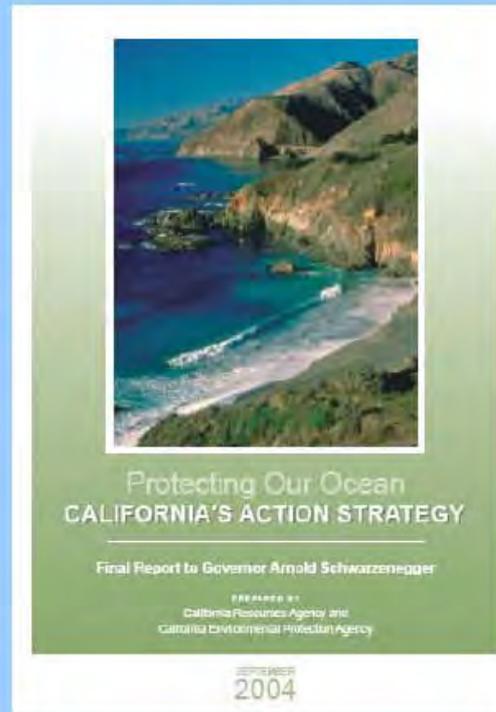
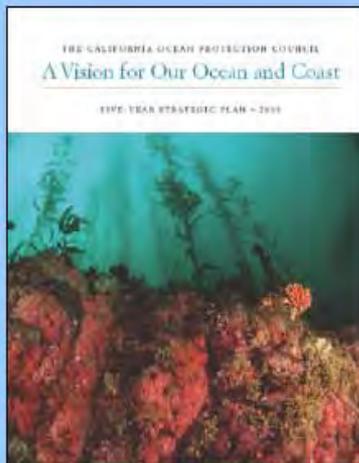
The U.S. Commission on Ocean Policy



Sustainable Fisheries Amendment
to the Magnuson-Stevenson Act

State Reports and Action Plans similarly require ecosystem-based management

California Marine Life Management Act



Seafloor Mapping in Oregon's Nearshore Environment

1999 – California expanded Ecosystem-Based Resource Management

Marine Life Protection Act



Requires California to create networks of
Marine Protected Areas (MPAs)

2004

Governor's Ocean Action Strategy

Implementation of

Marine Life Protection Act



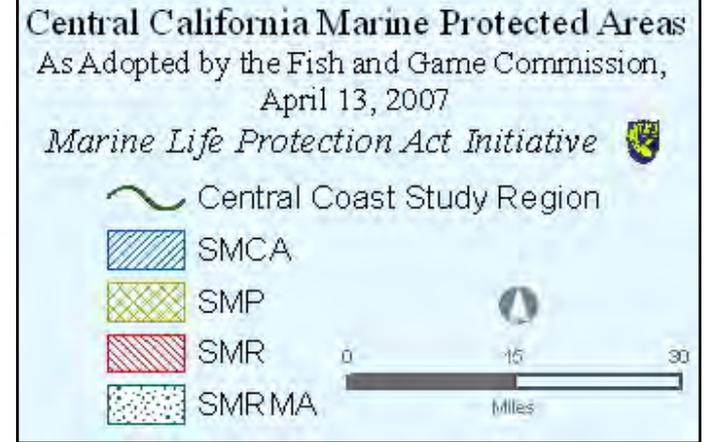
Protecting Our Ocean CALIFORNIA'S ACTION STRATEGY

Final Report to Governor Arnold Schwarzenegger

PREPARED BY
California Resources Agency and
California Environmental Protection Agency

SEPTEMBER
2004



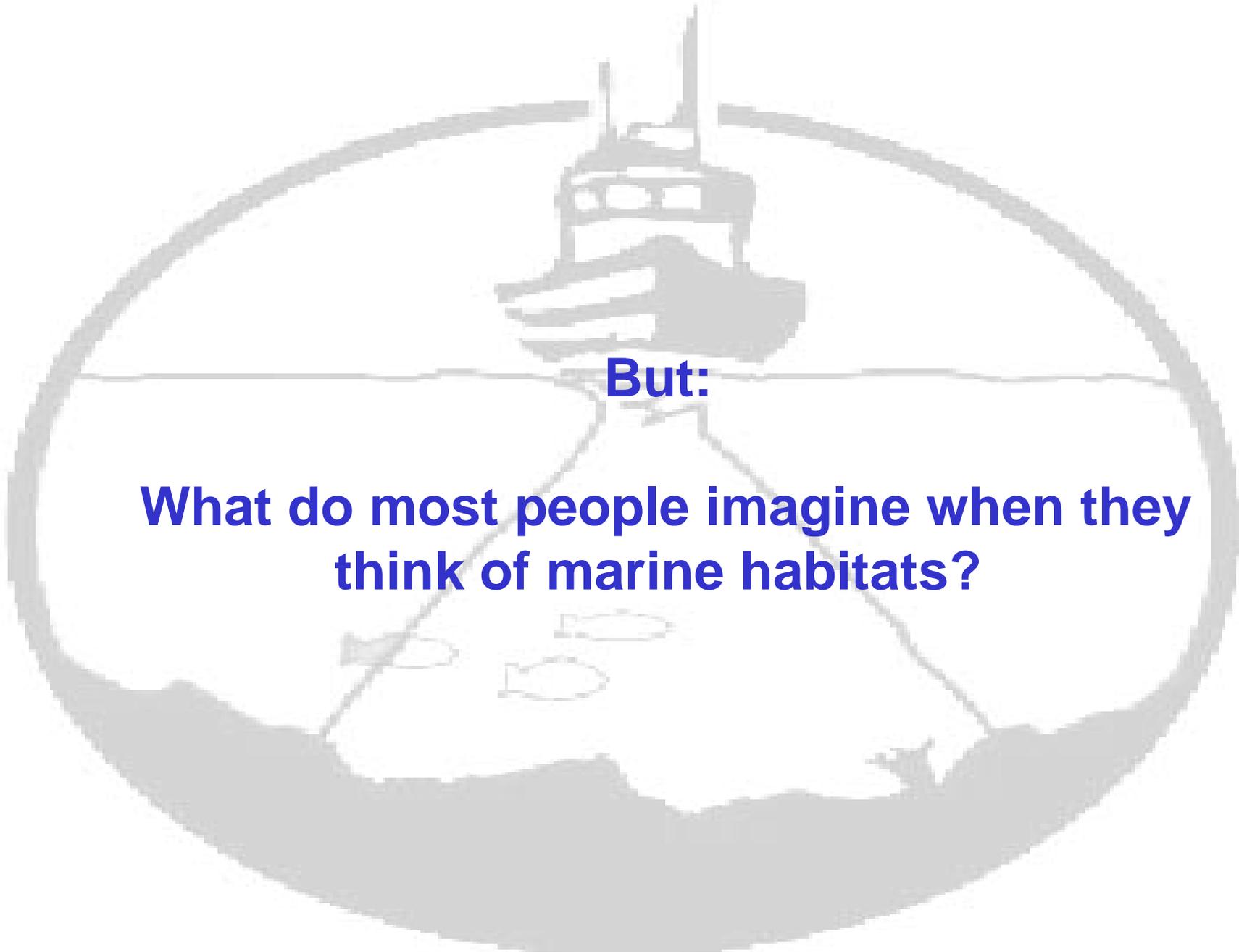


SMCA = state marine conservation area SMP = state marine park
SMR = state marine reserve SMRMA = state marine recreational management area

To be successful

All of these policies and programs for protecting coastal ocean ecosystems & economies require:

Detailed and comprehensive knowledge of our marine habitats.



But:

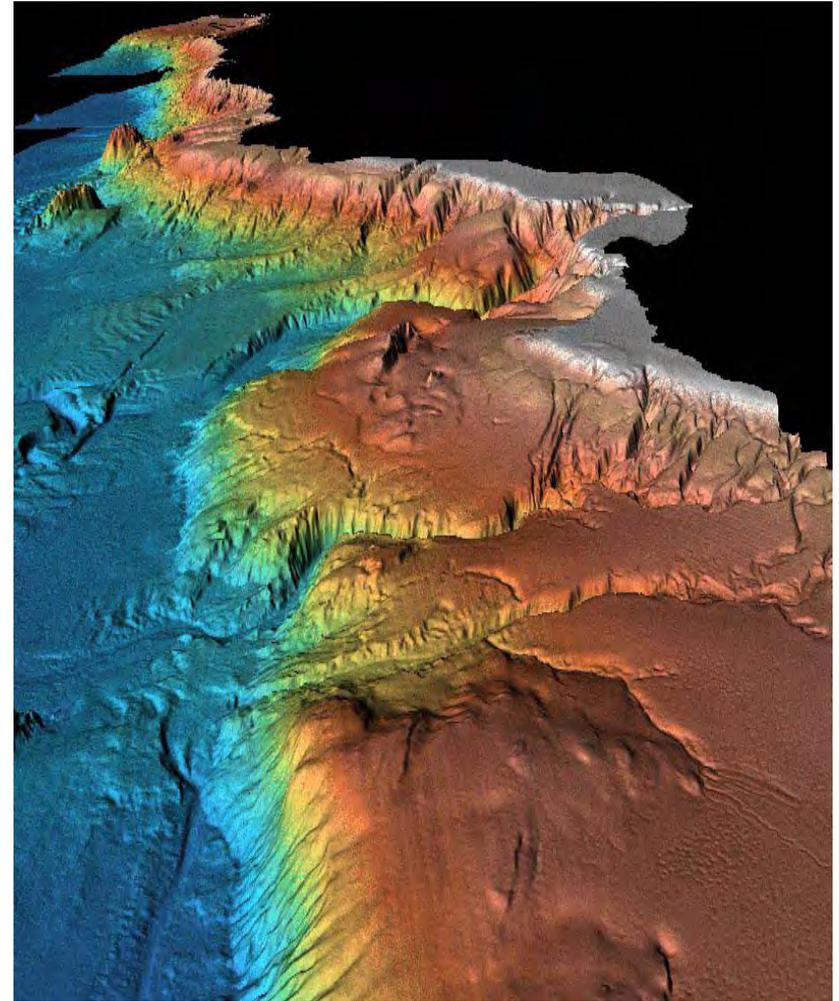
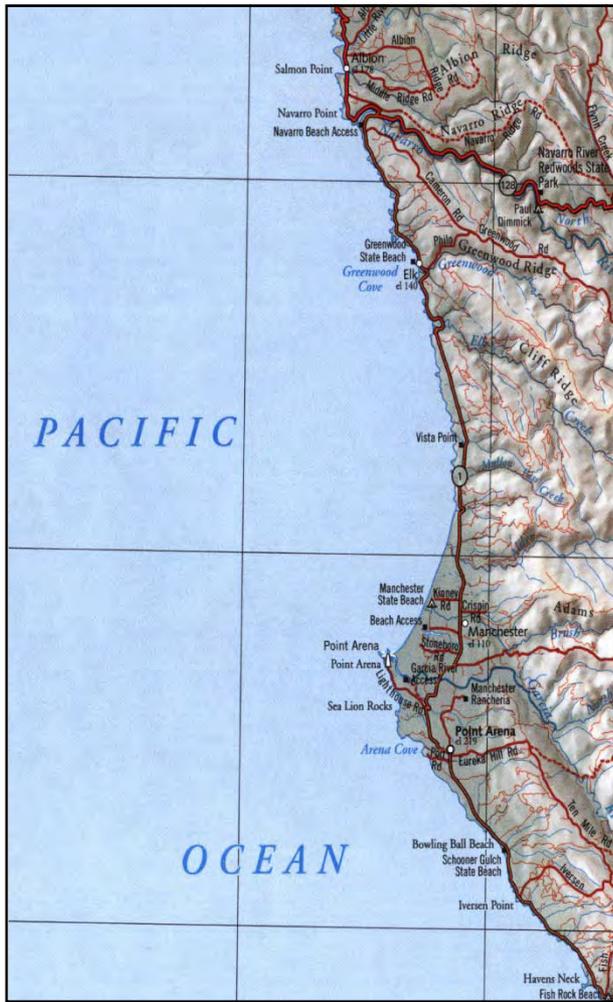
What do most people imagine when they think of marine habitats?



The
“Big Blue Area”

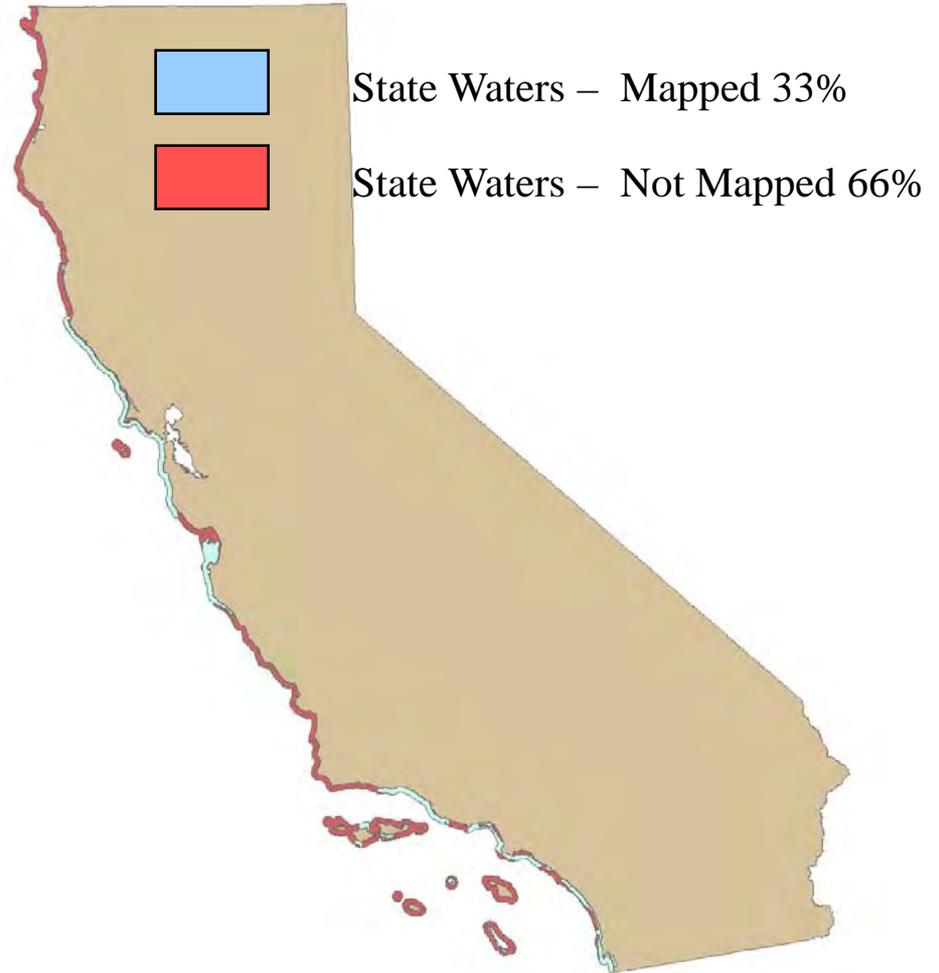
on the map

When in fact:



Marine seafloor habitats are as complex as terrestrial habitats.

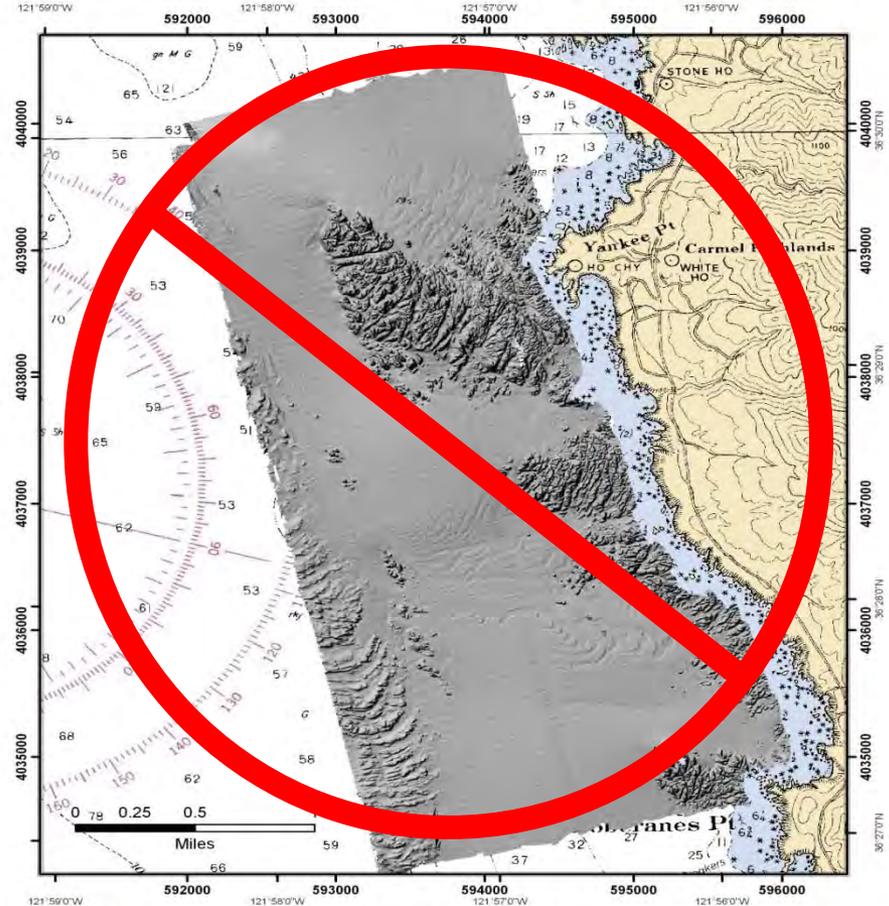
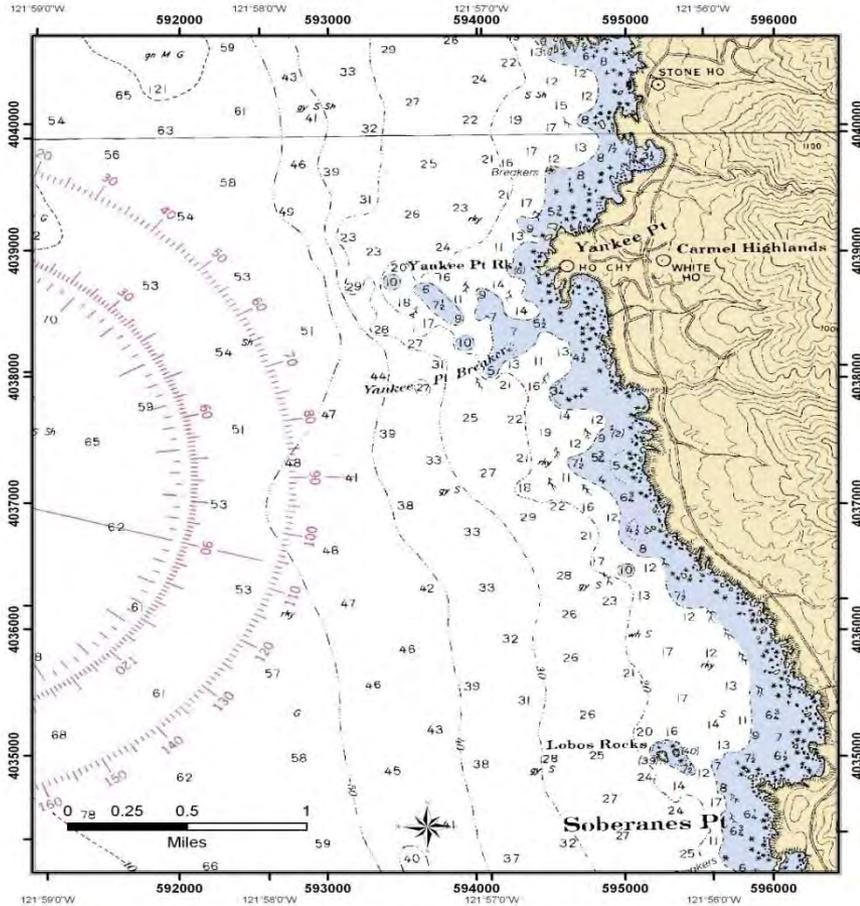
California State Waters (MHW – 3 NM)



for > 66% of California state waters

NOAA Chart 18686

Multibeam Bathymetry 3D Shaded Relief Model



Yankee Point, Big Sur Coast:

Map coordinates: UTM zone 10, WGS 84
<http://seafloor.csUMB.edu>



Yankee Point, Big Sur Coast:

Map coordinates: UTM zone 10, WGS 84
<http://seafloor.csUMB.edu>



2007

California Ocean Protection Council

Approves

\$15 m to launch

California Seafloor Mapping Project

Goal: Map all remaining state waters.



Coastal
Conservancy

CSMP– Collaborative Partnership

Agencies, Universities & Private Sector



CSUMB Seafloor Mapping Lab

Fugro Pelagos Incorporated

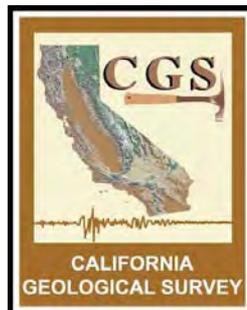
US Geological Survey



Center for Habitat Studies, Moss Landing Marine Labs

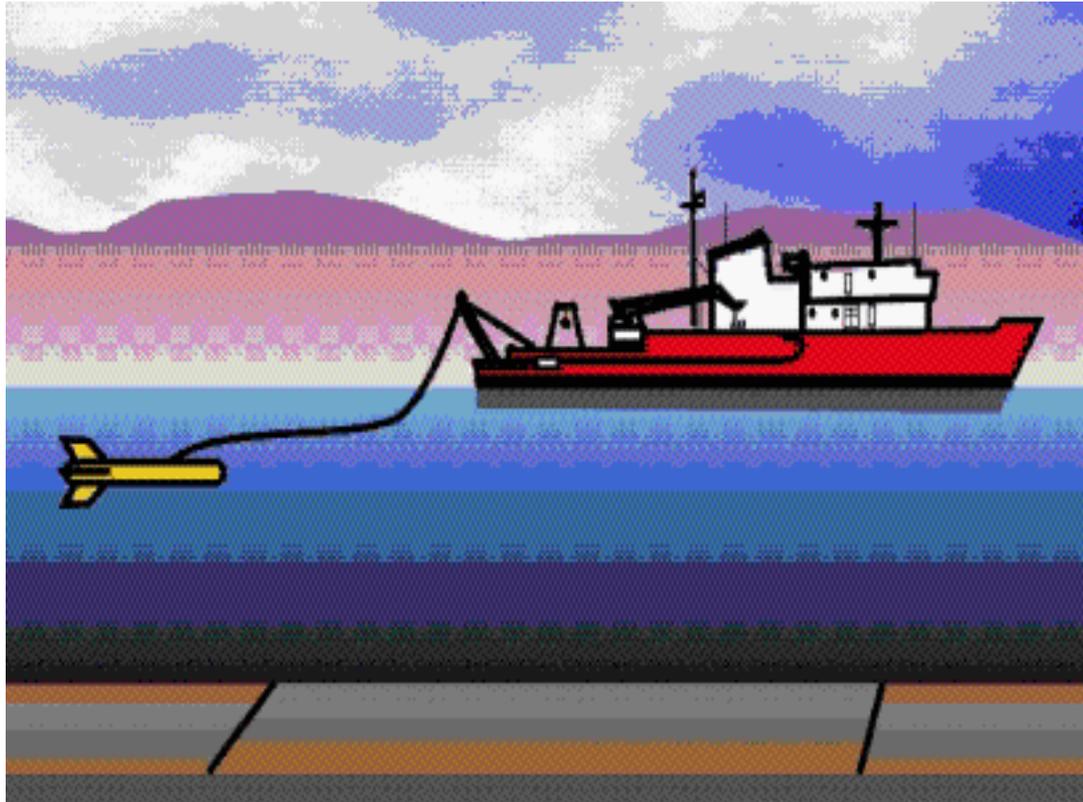


California Geological Survey



Acoustic Remote Sensing & Habitat Mapping

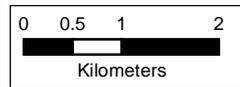
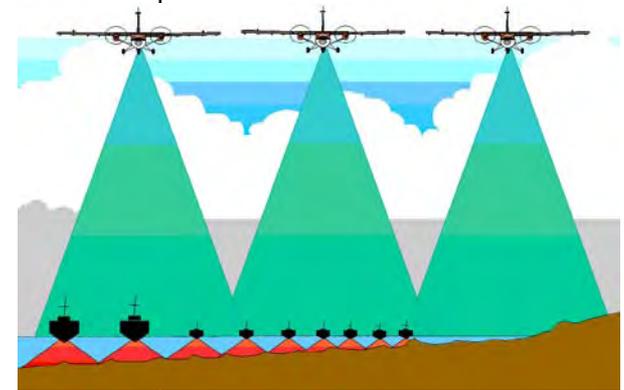
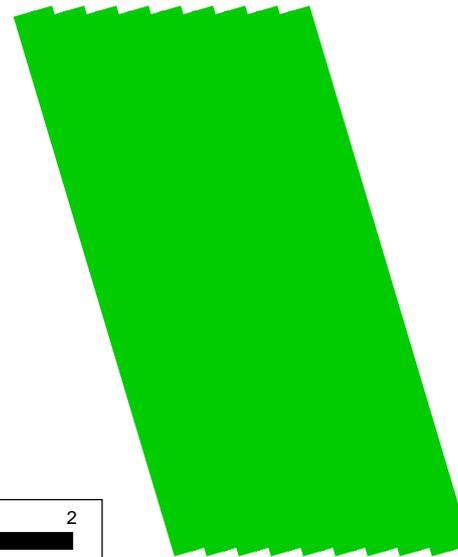
(a brief primer)



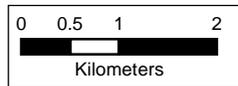
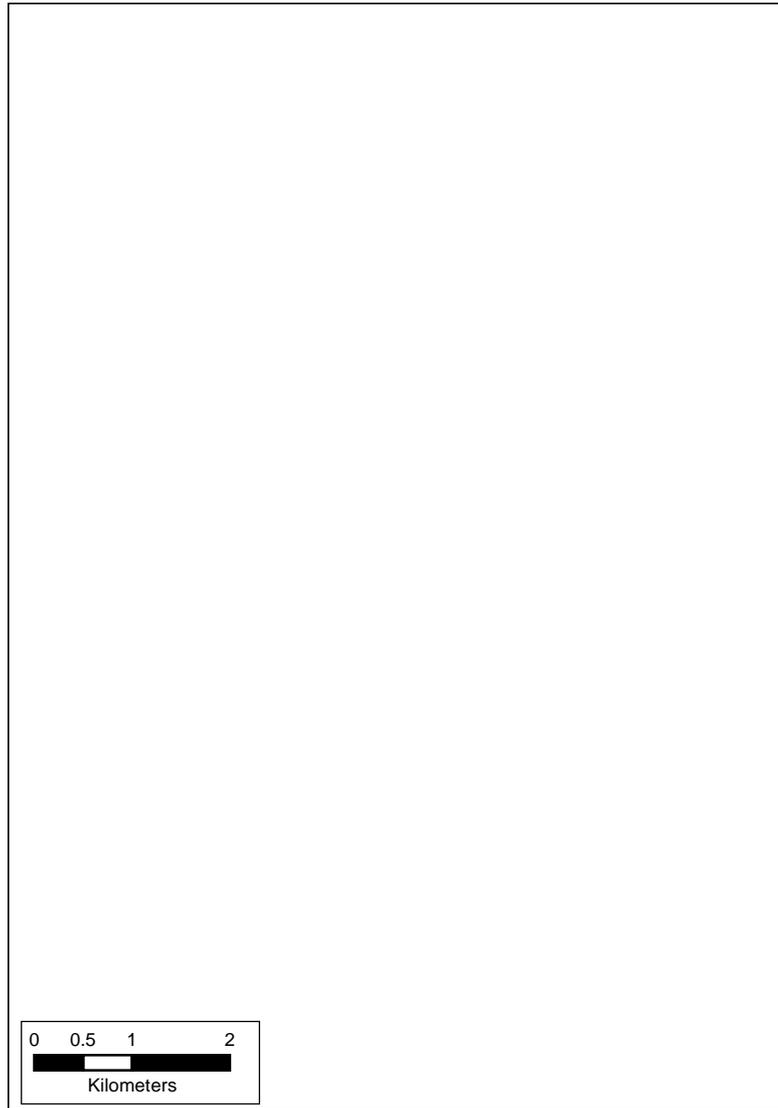
MPEG courtesy of CGS

Data
Acquisition
-
Multibeam
Sonar
& LIDAR

-
Mowing the
Lawn



Seafloor Mapping Data - Billions of Depth Soundings



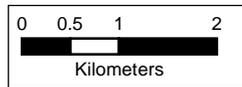
Tier 1 products



Seafloor
Mapping
Products
-
Digital
Elevation
Model
(DEM)
or
Raster Grid
of evenly
spaced values
(2m resolution)

Tier 2 products

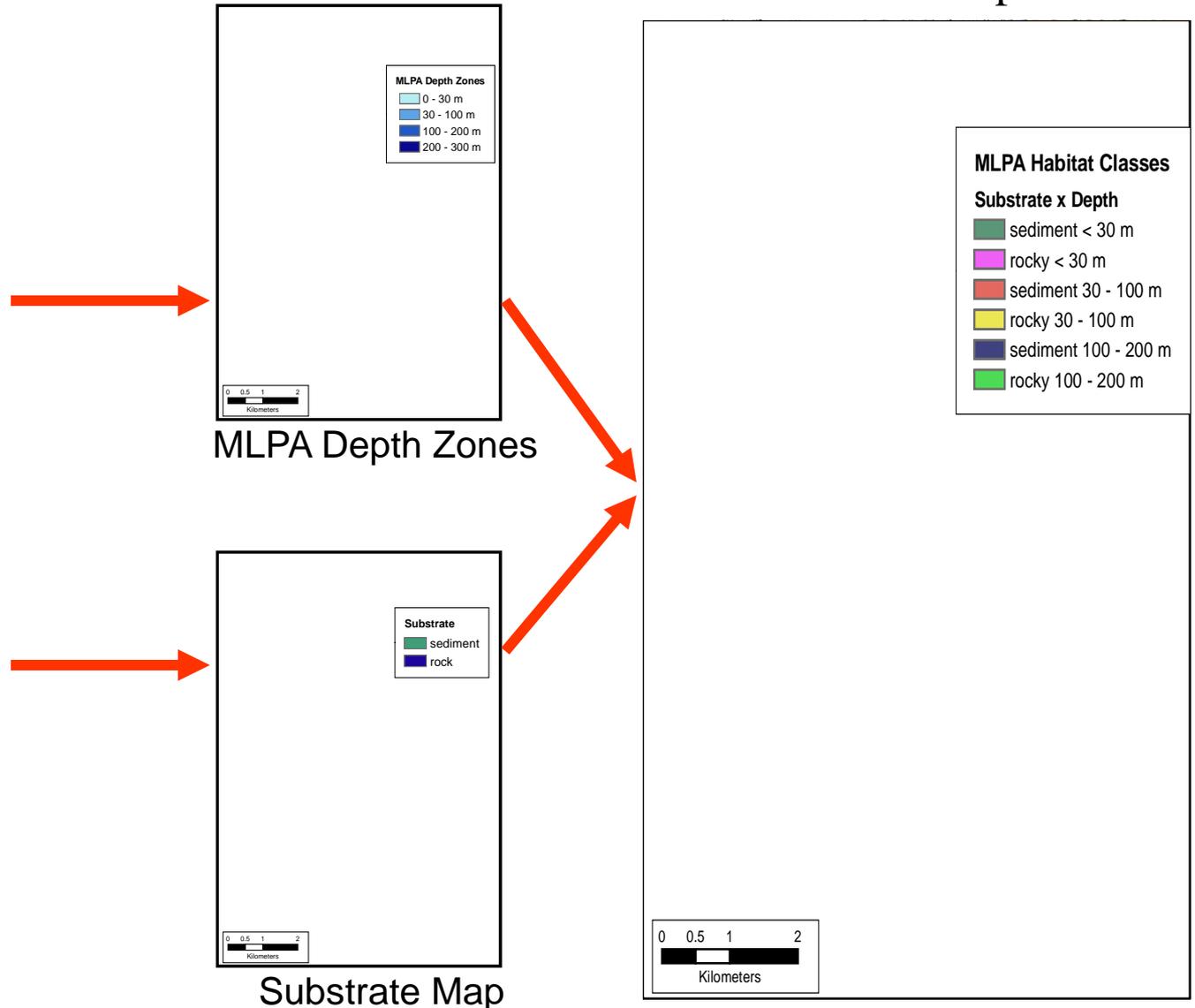
Seafloor
Mapping
Products
-
DEM
in
Shaded Relief



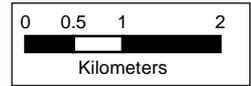
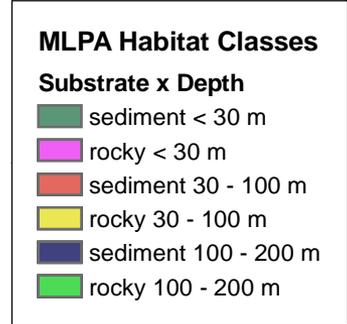
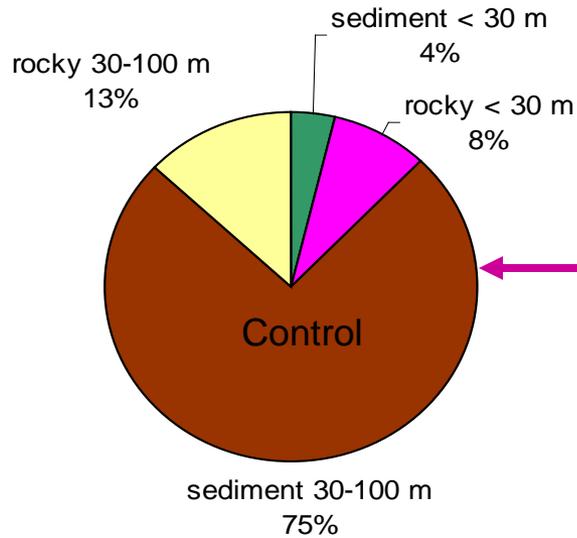
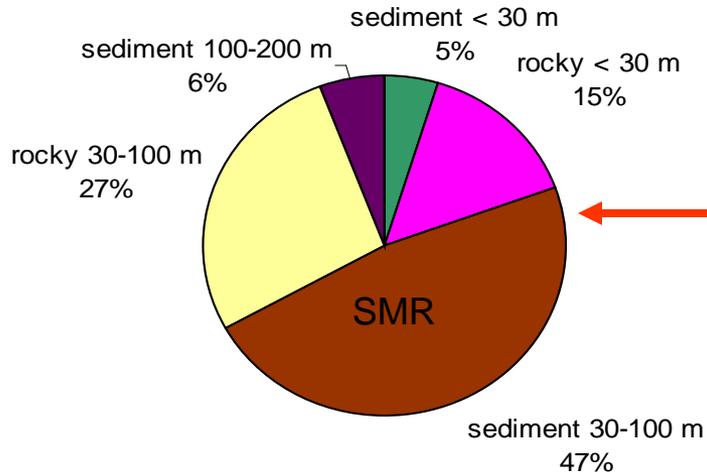


Supervised MLPA Habitat Auto-Classification from DEM (depth zones + substrate)

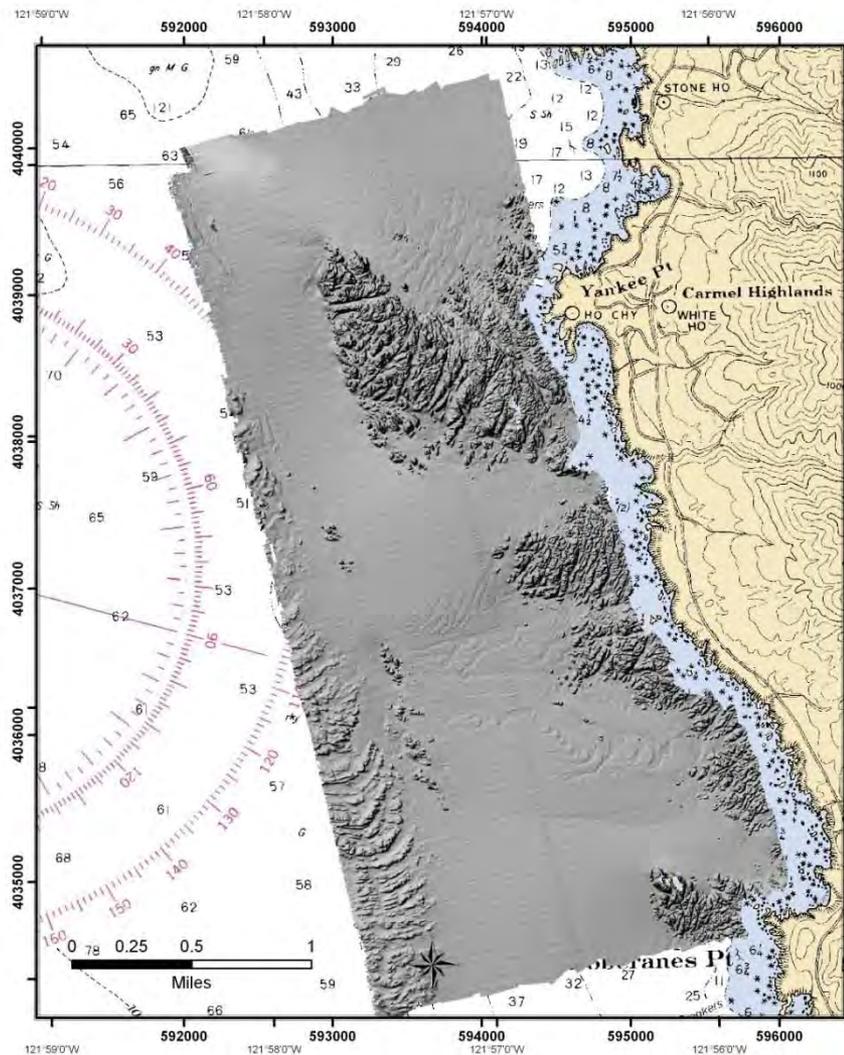
Enhanced Tier 2 products



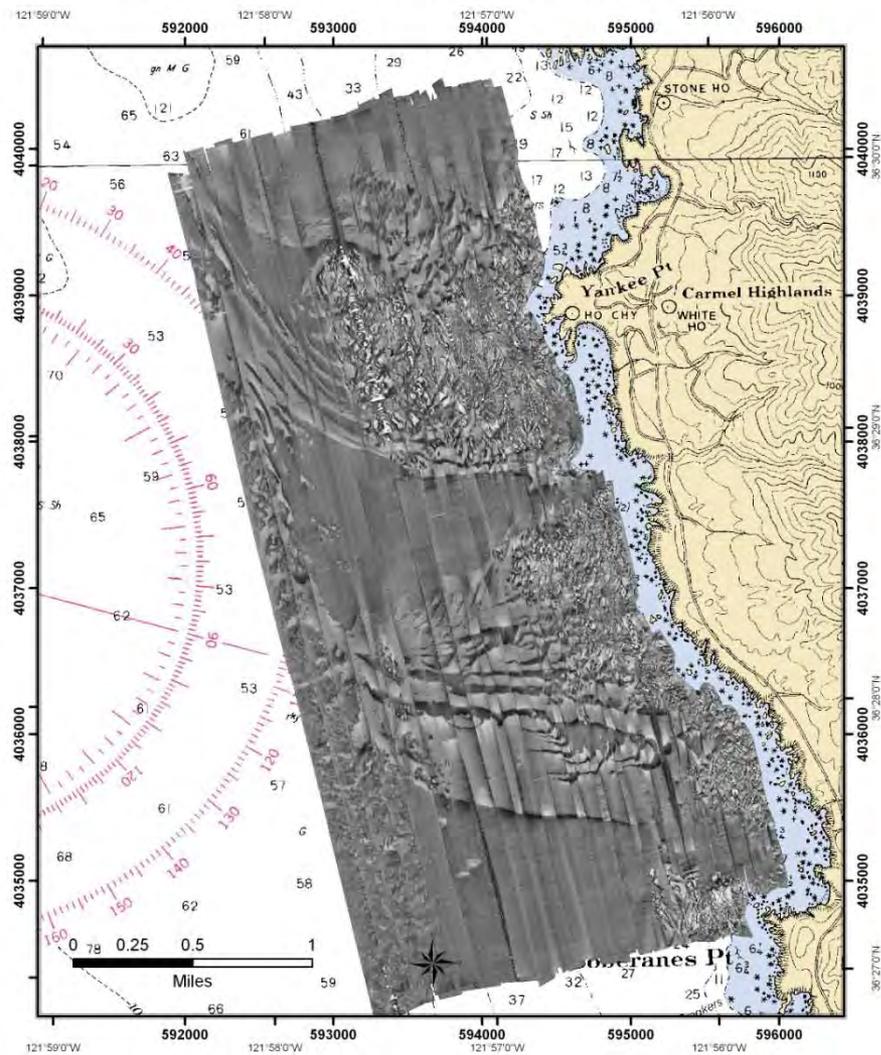
Automated Quantitative Comparison of Habitat Abundance



Multibeam Bathymetry 3D Shaded Relief Model



Sidescan Sonar 2D Backscatter Imagery



Yankee Point, Big Sur Coast:

Map coordinates: UTM zone 10, WGS 84
<http://seafloor.csUMB.edu>



Yankee Point, Big Sur Coast:

Map coordinates: UTM zone 10, WGS 84
<http://seafloor.csUMB.edu>



Seafloor Mapping Products

-

Sediment Classification from Sidescan Sonar Mosaic

MLPA Habitat Classes

Substrate x Depth

 sediment < 30 m

 rocky < 30 m

 sediment 30 - 100 m

 rocky 30 - 100 m

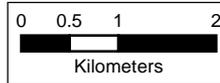
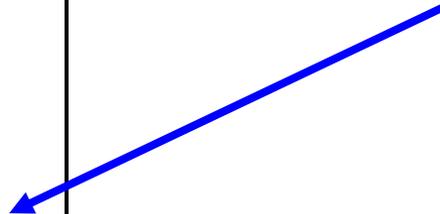
 sediment 100 - 200 m

 rocky 100 - 200 m

Sidescan Sonar

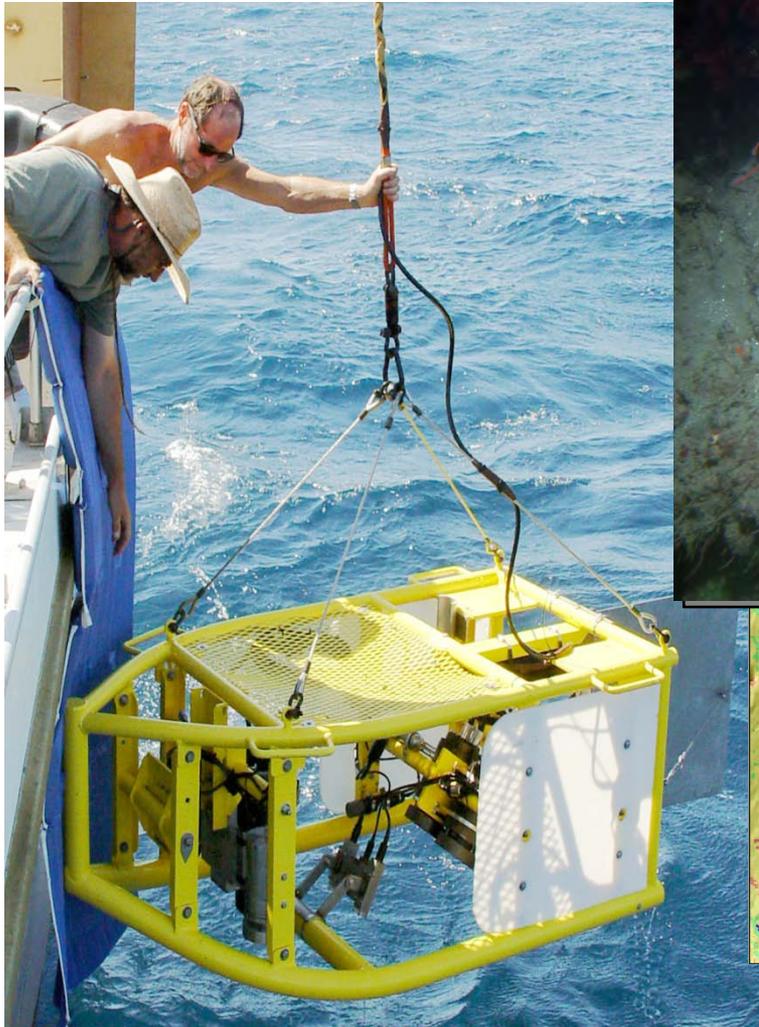
 High : 255

 Low : 0



Video Groundtruthing

(limited & strategic)

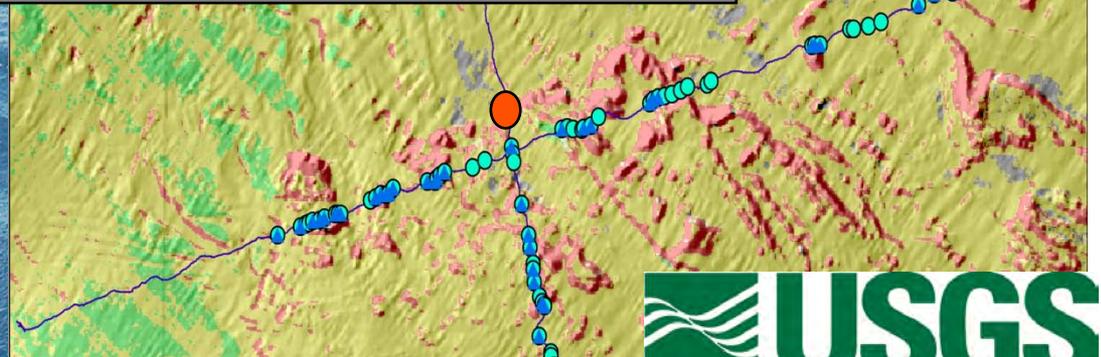


Binary Facies Classification
in Horseshoe Kelp Region

200 0 400 Meters

Explanation
(or, minor components)

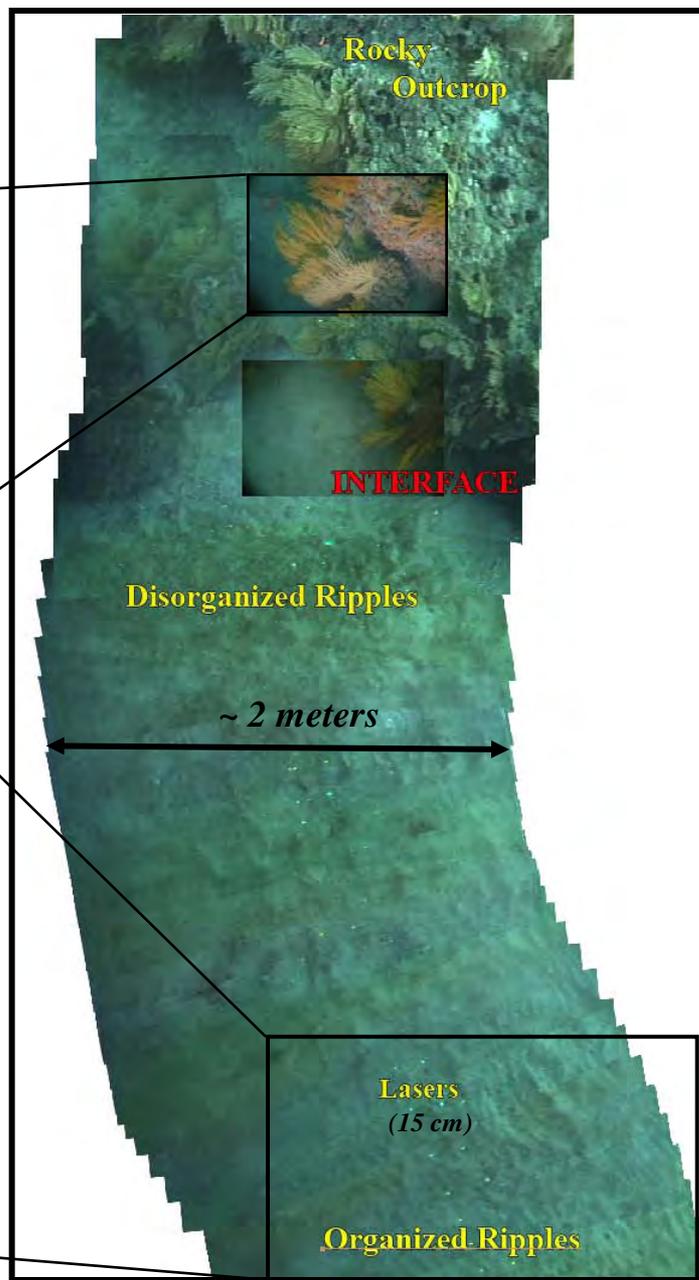
- ▲ Rock/Rock
- Rock/Rock or Rock/Cobb
- Camera Transect



Video Mosaic With Geo-referenced Still Photographs



6 Mpixel

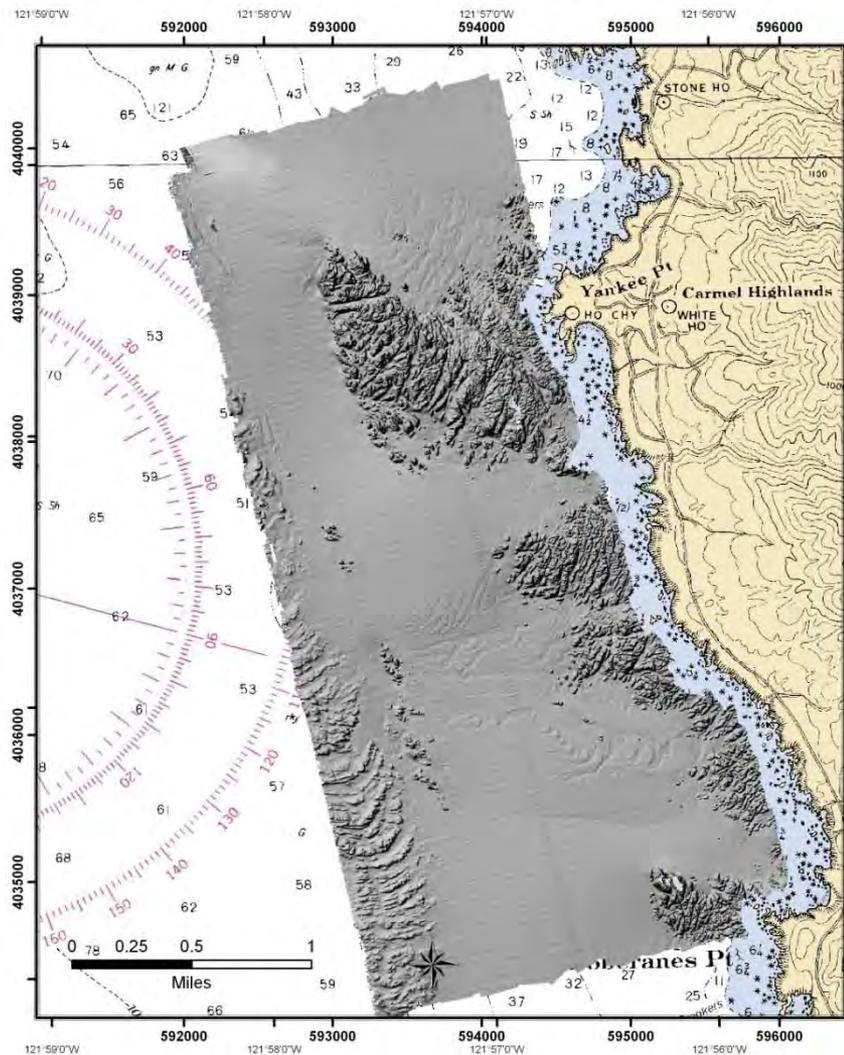


72 dpi

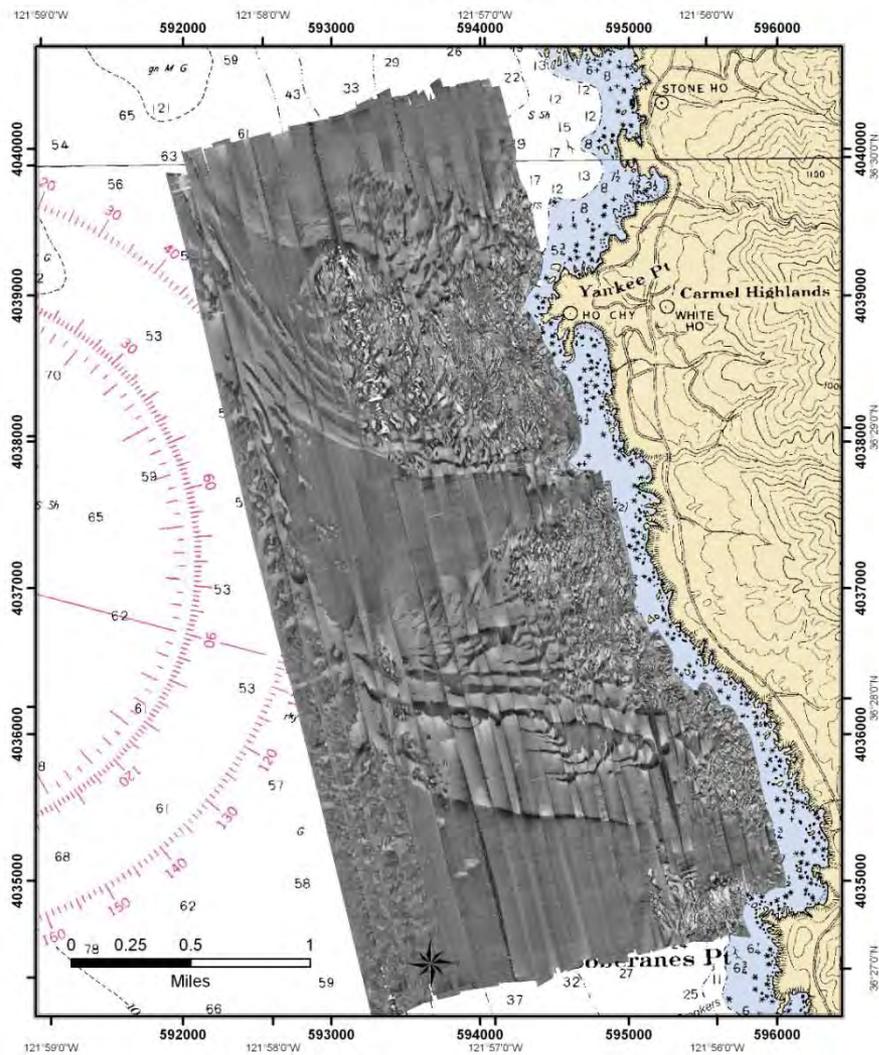
But:

Is surface mapping the seafloor enough?

Multibeam Bathymetry 3D Shaded Relief Model



Sidescan Sonar 2D Backscatter Imagery



Yankee Point, Big Sur Coast:

Map coordinates: UTM zone 10, WGS 84
<http://seafloor.csUMB.edu>



Yankee Point, Big Sur Coast:

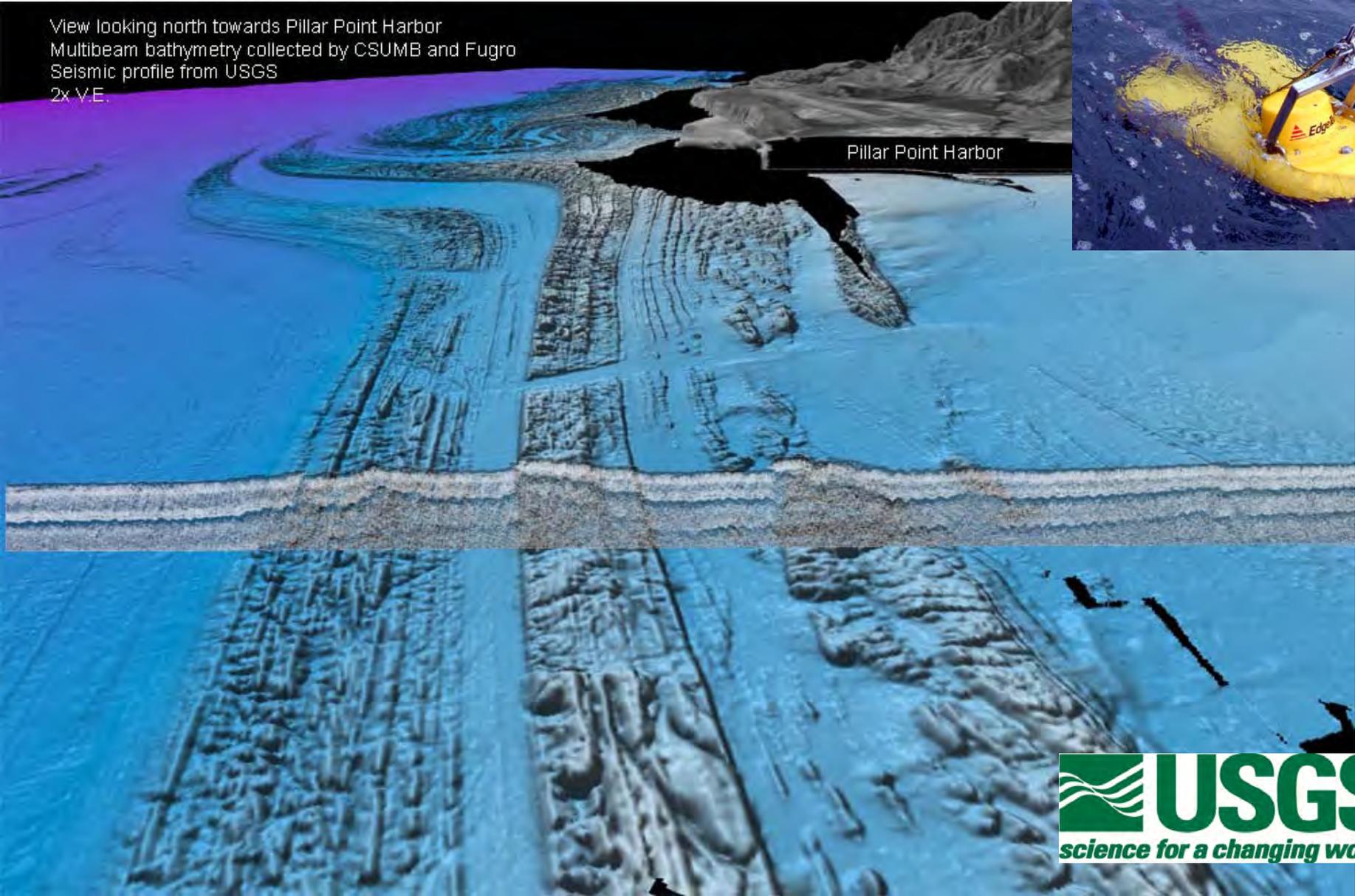
Map coordinates: UTM zone 10, WGS 84
<http://seafloor.csUMB.edu>

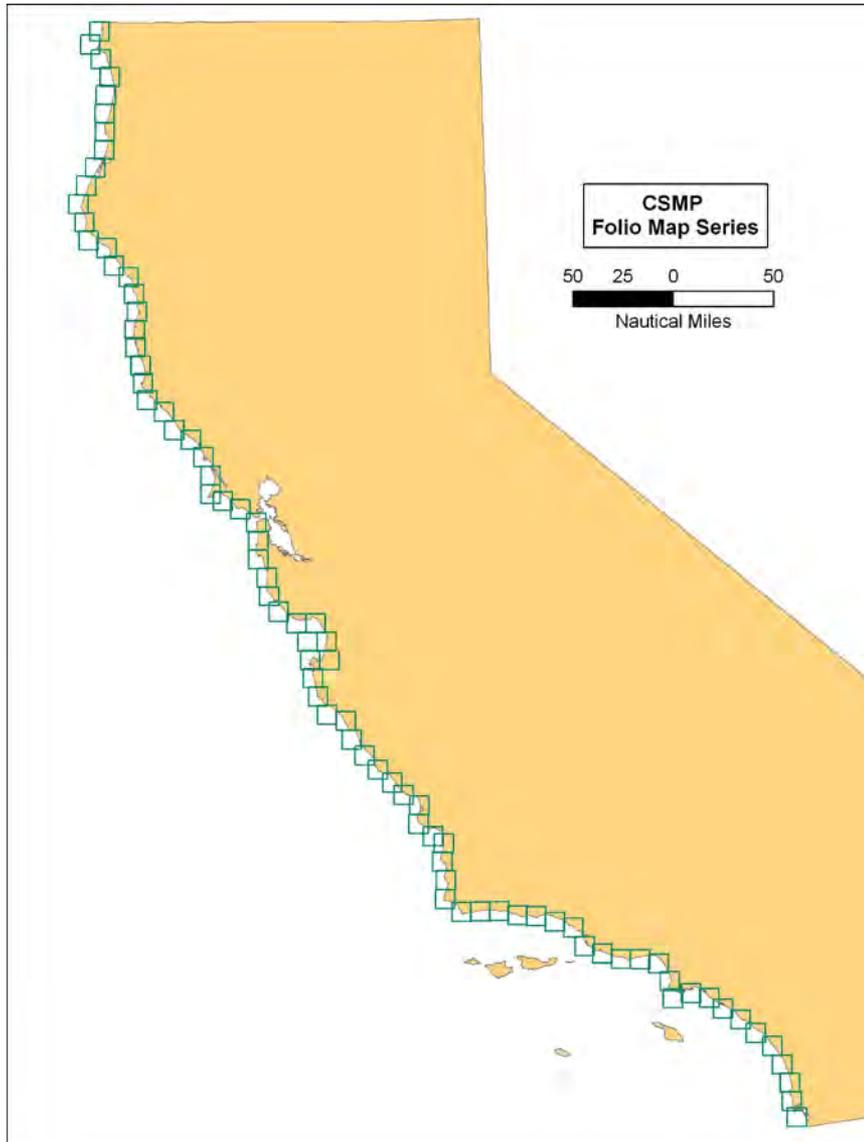


Sub-bottom Profiling

(limited & strategic)

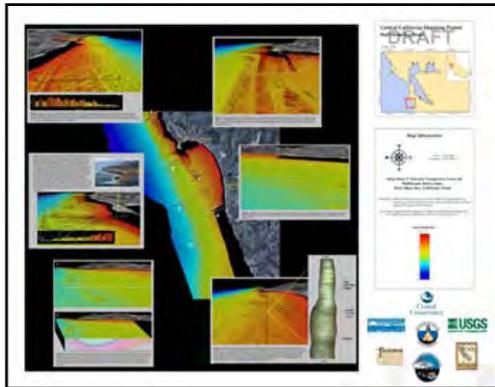
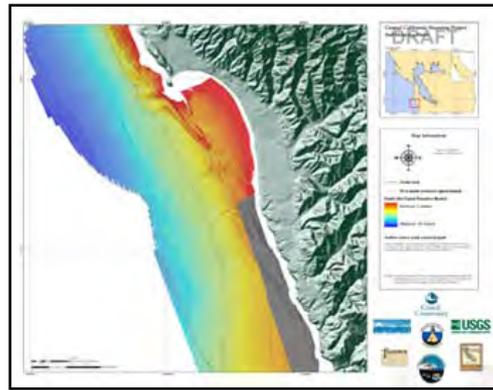
View looking north towards Pillar Point Harbor
Multibeam bathymetry collected by CSUMB and Fugro
Seismic profile from USGS
2x V.E.



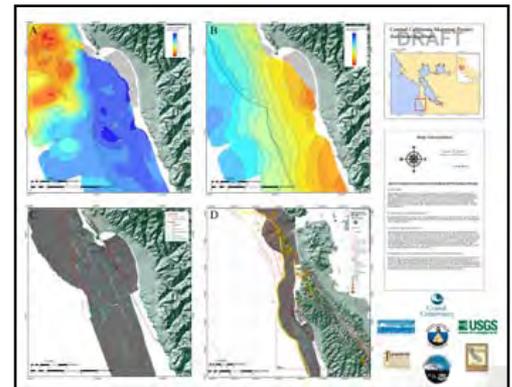
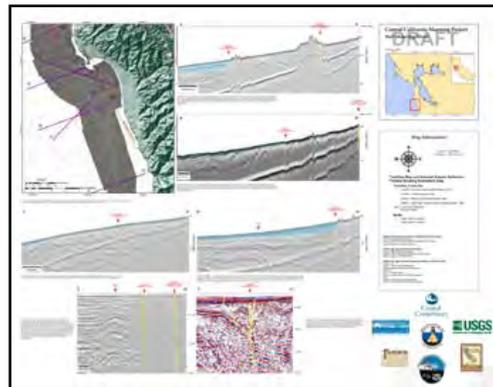
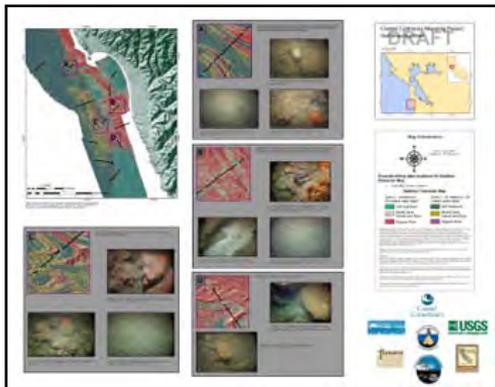
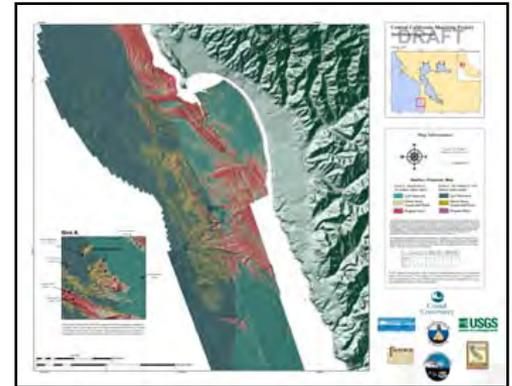


**What's
going to
happen with
all those
data?**

**GIS Layers
&
Folio Map
Series
Products**

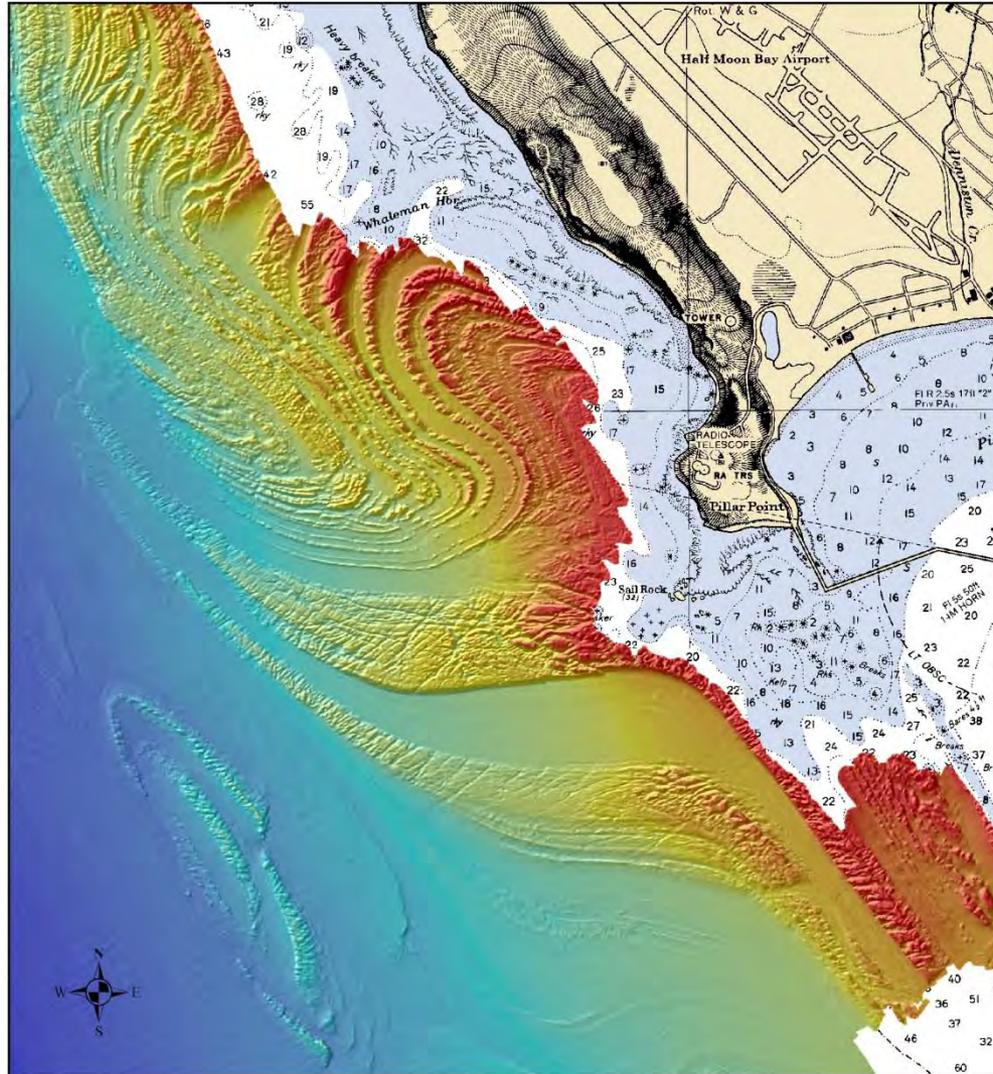


CSMP Folio Map Series Tiers 1 & 2



Has this been a good investment?

Mavericks Surf Sight – Half Moon Bay, Ca



MONTEREY HERALD
 THE MONTEREY, PEBBLE BEACH AND SALINAS VALLEY VOICES
 Thursday, May 24, 2007
 www.montereyherald.com

Memorial Day
 County has activities for remembrance, celebration, B1

Ex-officer's final argument
 COUNCIL TO DECIDE STATUS OF McMAHON'S FIRING
 BY ERIN REYNOLDS
 Herald Staff Writer

In a final hearing before the Monterey County Council on Tuesday, John McMahon argued for his reinstatement as police chief. McMahon, who was fired last week, argued that his firing was unjust and that he should be reinstated. The council will vote on whether to reinstate McMahon or to uphold his firing.

State short on educated work force
 REPORT: ECONOMY CAN'T RELY ON GRADUATES FROM ABROAD
 BY WALT KERRICK
 Staff Writer

California's economy and colleges are in a bind. The state is short on educated workers, and colleges are struggling to provide the education needed to fill the gap. A report from the California Education Trust states that the state's economy is increasingly dependent on graduates from abroad, but that the state's education system is not producing enough graduates to meet the demand.

DEEP-SEA SIGHT
 SCIENTISTS PEER UNDER WAVES TO MAP OCEAN FLOOR
 BY ELISA ROSENWITZ
 Herald Staff Writer

Scientists have used a deep-sea camera to capture the first ever image of a hydrothermal vent on the seafloor. The image shows a black smoker, a type of hydrothermal vent that spews superheated, mineral-rich fluids. The discovery is significant because it provides the first direct evidence of a hydrothermal vent on the seafloor.

Top officials forge new Iraq policy
 BY JOHN SALZETT
 Staff Writer

WASHINGTON — U.S. officials are forging a new Iraq policy, one that focuses on political change in Iraq. The new policy is being developed by the State Department and the Defense Department, and it is expected to be announced in the coming weeks.

Pajaro agency loses on appeal
 WATER DISTRICT MAY HAVE TO REFUND \$4M
 BY ERIN REYNOLDS
 Herald Staff Writer

A state appellate court ruling may require the Pajaro Valley Water Management Agency to refund \$4 million in water rate increases to its customers. The court ruled that the agency's rate increases were not justified, and that the agency must refund the money to its customers.

California Newspapers



Steve McMahon
 Former police officer
 had a fight with
 other with the role of
 a mayor defendant



We are
 dependent
 on other
 suppliers, on
 its speak,
 both have
 California state
 recently come
 from other areas in espe-
 cially difficult in Monterey
 County.

Photo on Salinas page A18



Photo on Iraq page A18

Photo on Water page A18



Photo on Salinas page A18

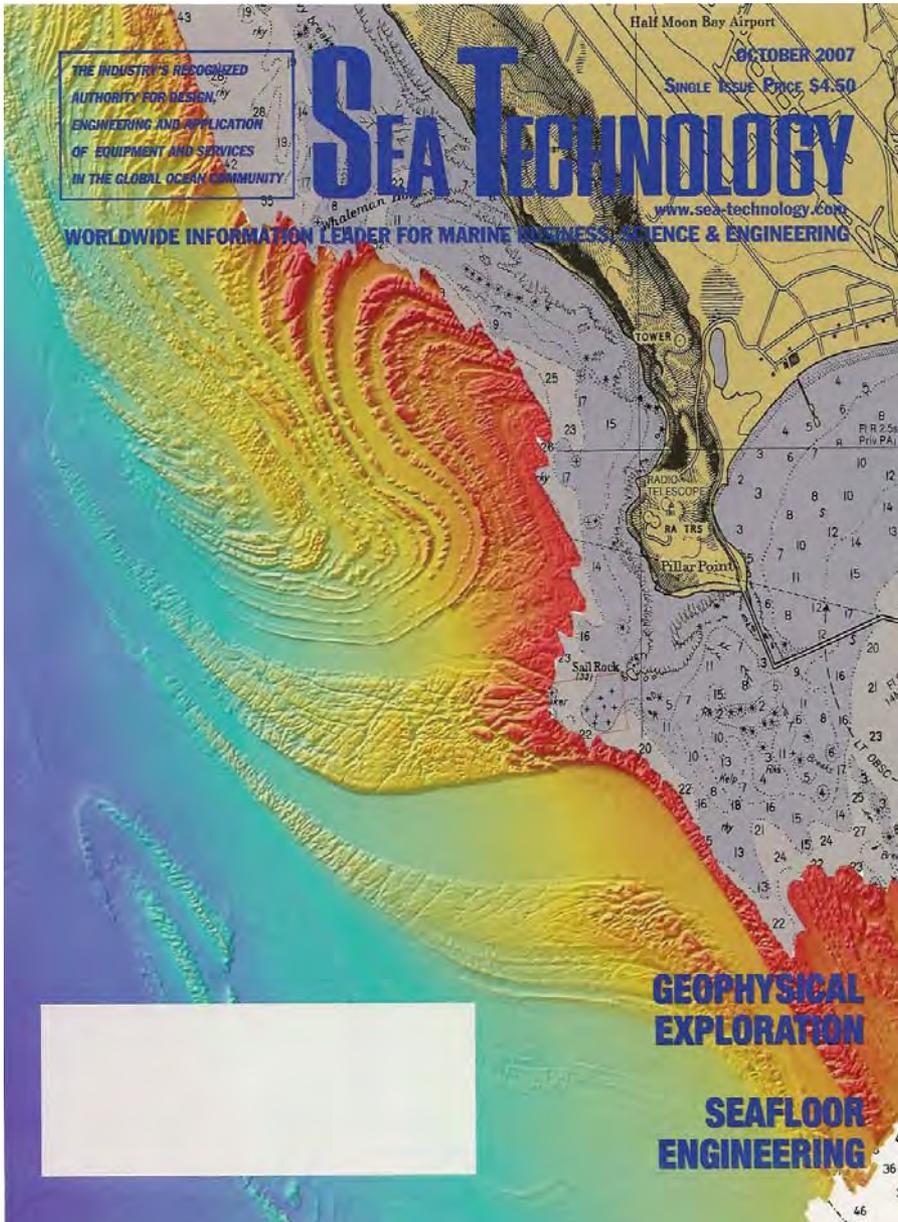
Photo on Iraq page A18

Photo on Water page A18



Photo on Water page A18

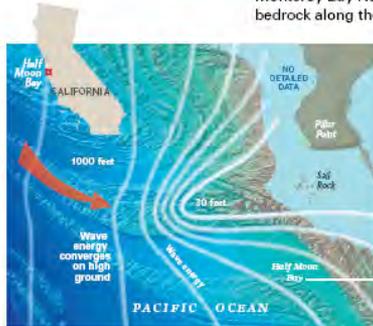
Photo on Water page A18



Cover of Sea Technology



Surfer Matt Ambrose avoids the maw of a 40-foot wave at "Mavericks" in the finals of a 2006 contest.



Surly Surf Some of the largest waves to hit the mainland U.S. are at "Mavericks," surfer slang for the risky rocky reef off California's Half Moon Bay. Now scientists hunting for fish habitat have discovered why. Working with the California Ocean Protection Council, researchers used sonar and other sensors to create a detailed map of the seafloor under the surf break—part of the Monterey Bay National Marine Sanctuary. It turns out a tongue of bedrock along the San Gregorio Fault juts into the Pacific just below

the surf zone. Intricate folds of eroded sandstones from the Tertiary period form stair-like ledges between deeper canyons that focus wave energy, creating peaks up to 40 feet high during big swells. Gary Greene, a marine geologist on the project, notes the reef is popular with not only with surfers but also the state's overfished rockfish, making it a good candidate for a marine protected area.

Matt Ambrose (above) often gets the rockfish-eye view, whether wiping out in monster surf or diving the reef on calm days. "Those [underwater] hills look like mushroom heads, undercut with cracks and caves," he says. And the waves are tougher than any he's ridden "by miles." —*Joel K. Bourne, Jr.*

PHOTO: KEVIN GERMAN, SACRAMENTO BEE; NGM MAPS

Magazine

The New York Times



Television





Marine Life Protection Act

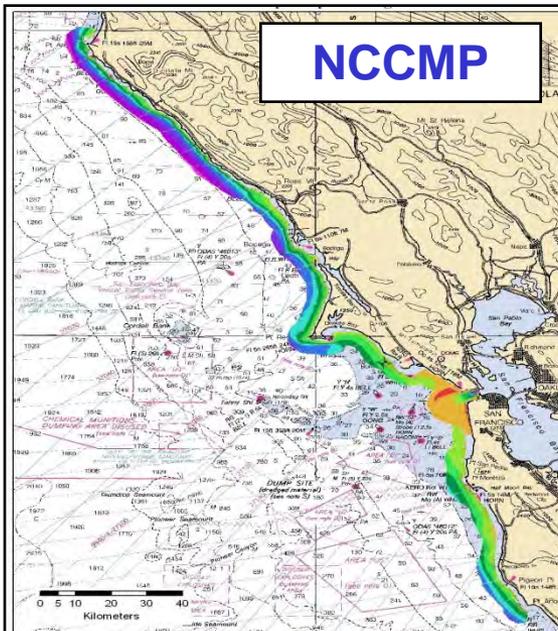


Requires California to designate a network of **Marine Protected Areas** (MPAs)

MPA Design



“The new seafloor maps are unbelievable! They have made the MPA selection process in this next leg of the MLPA so much easier than the first, because now we can see every reef along that coast. The maps are invaluable to scientists and stakeholders in the location and design of the MPA’s.”



Mark Carr

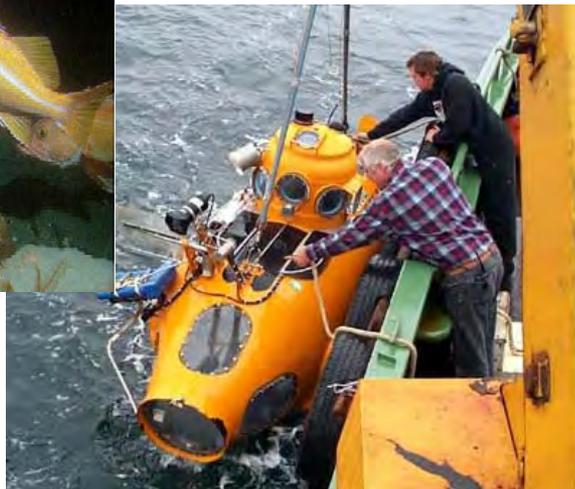
MLPA Science Advisory Team

Research Faculty – UC Santa Cruz

MPA Monitoring (\$20m)



“Please know that the seafloor mapping of the MPA’s has been A HUGE HELP to us both in designing the surveys and in planning and executing the dives. The location and depths of the rock features in your maps have been dead-on! I only wish we had this resolution of data for all the MPAs! Thank you and your entire team very much.”



Mary Yoklavich
MLPA Science Advisory Team
Research Fishery Biologist
NOAA Fisheries



Gina Wade



MiRa Park

DFG & MLPA GIS Lab Staff
CSUMB/SFML Geospatial Technology Graduates



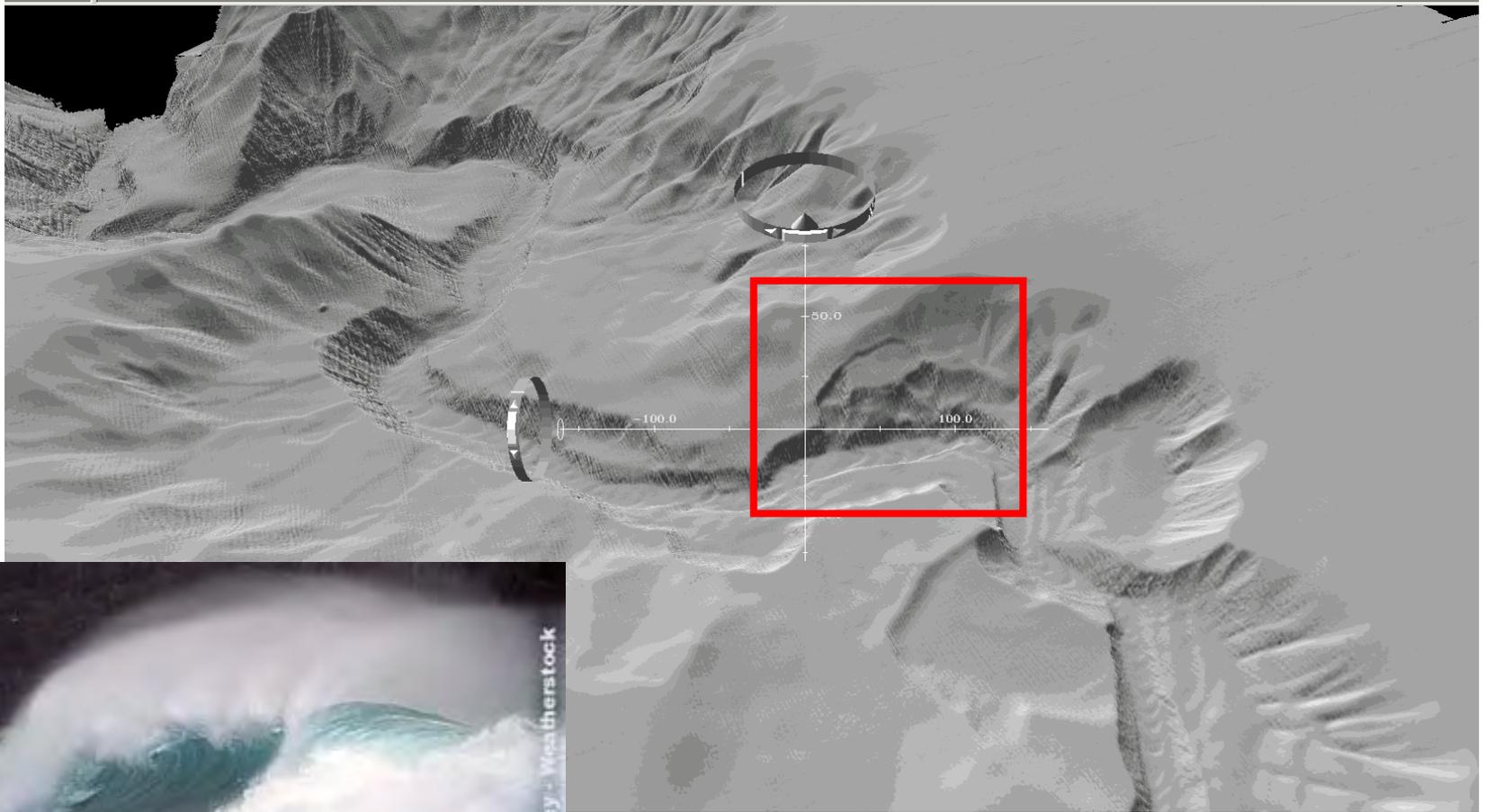
Paulo Serpa



Matt Johnson

**What are we seeing in the state waters data?
&
How are they being used?**

Tsunamigenic Landslides in Submarine Canyons



Discovering Historic Ship Wrecks

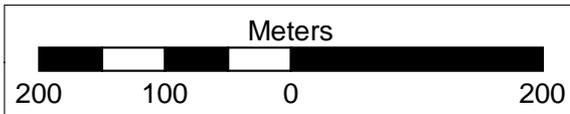
CREW FLEES BURNING SHIP

Los Angeles Times (1886-Current File); Mar 4, 1923; ProQuest Historical Newspapers Los Angeles Times (1881 - 1985)
pg. 17

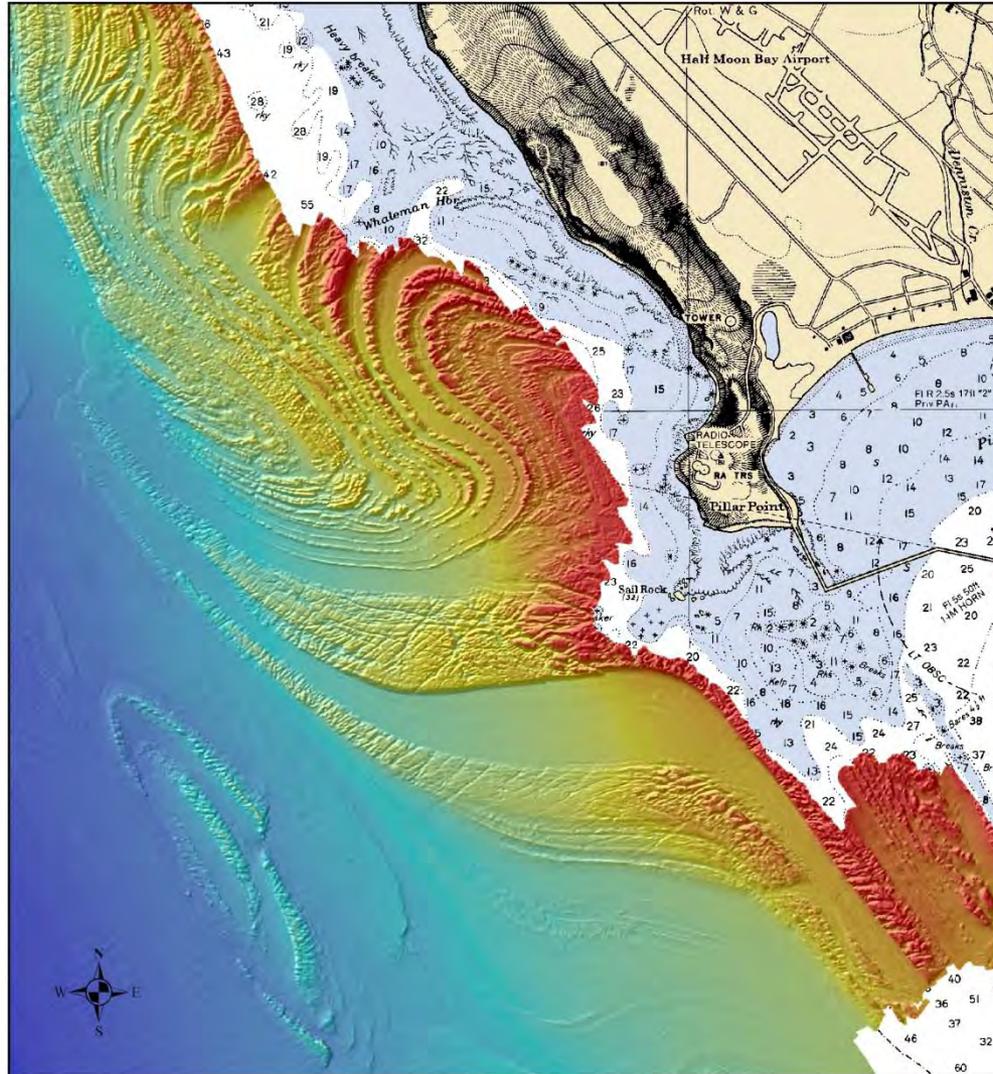
CREW FLEES BURNING SHIP

*Twenty Take to Boats as Flames Destroy Babinda,
Motor Vessel, Off Santa Cruz Coast*

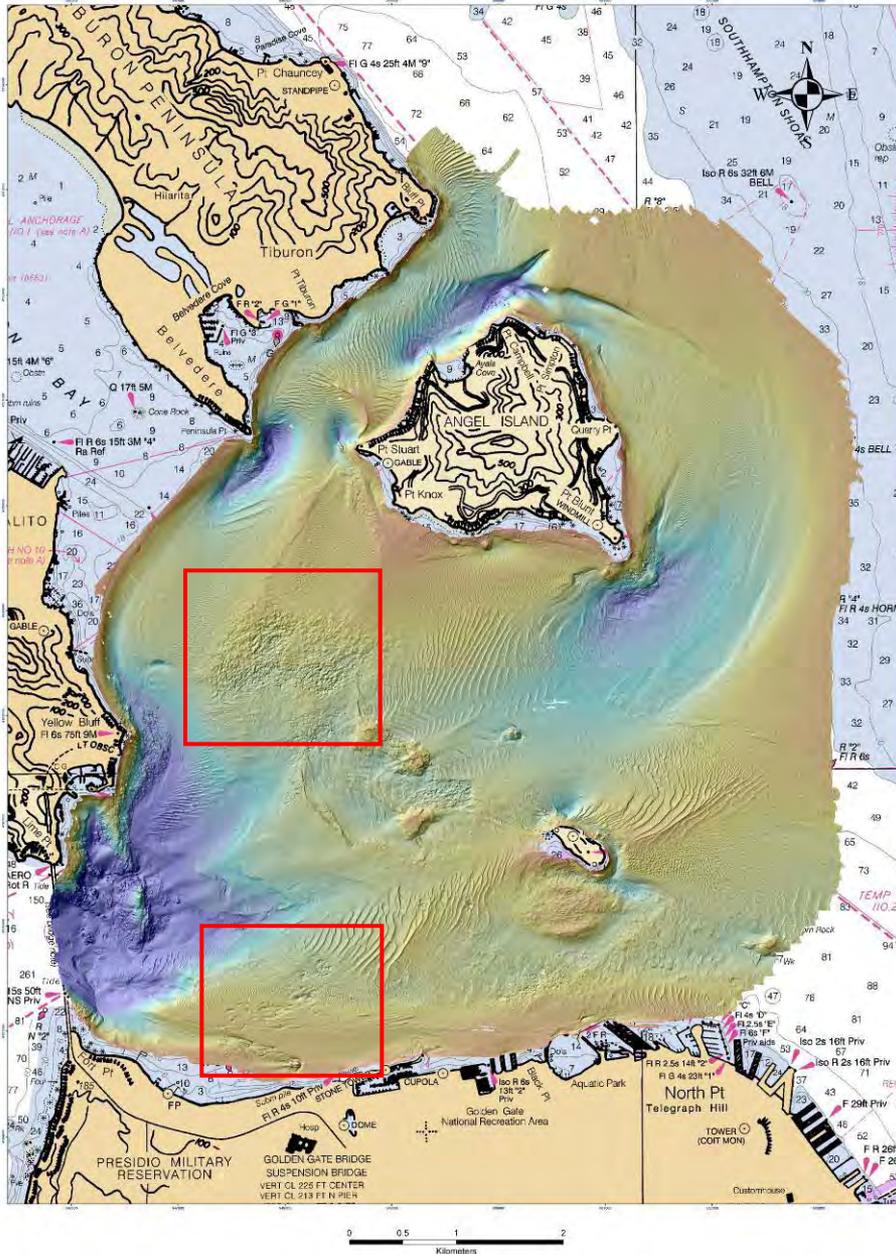
With the motorship Babinda a mass of flames, Capt. Frank Marland and a crew of twenty escaped yesterday in small boats, according to radio messages received at Los Angeles Harbor.



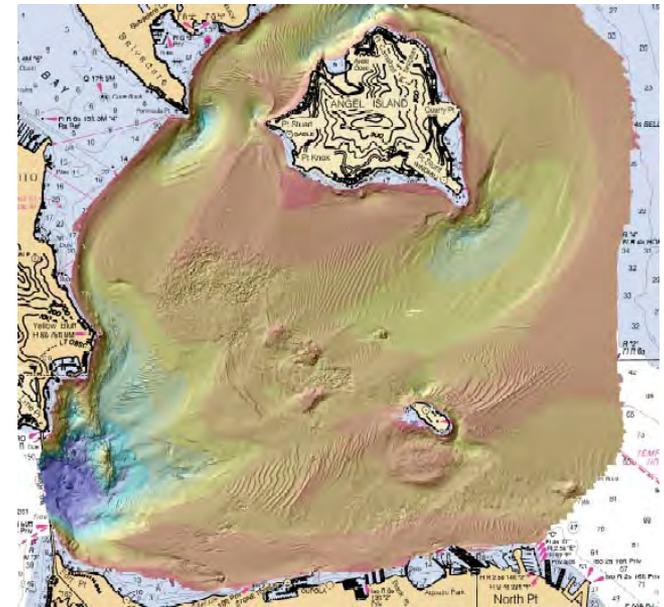
Geohazards, Faulting & Plate Tectonics



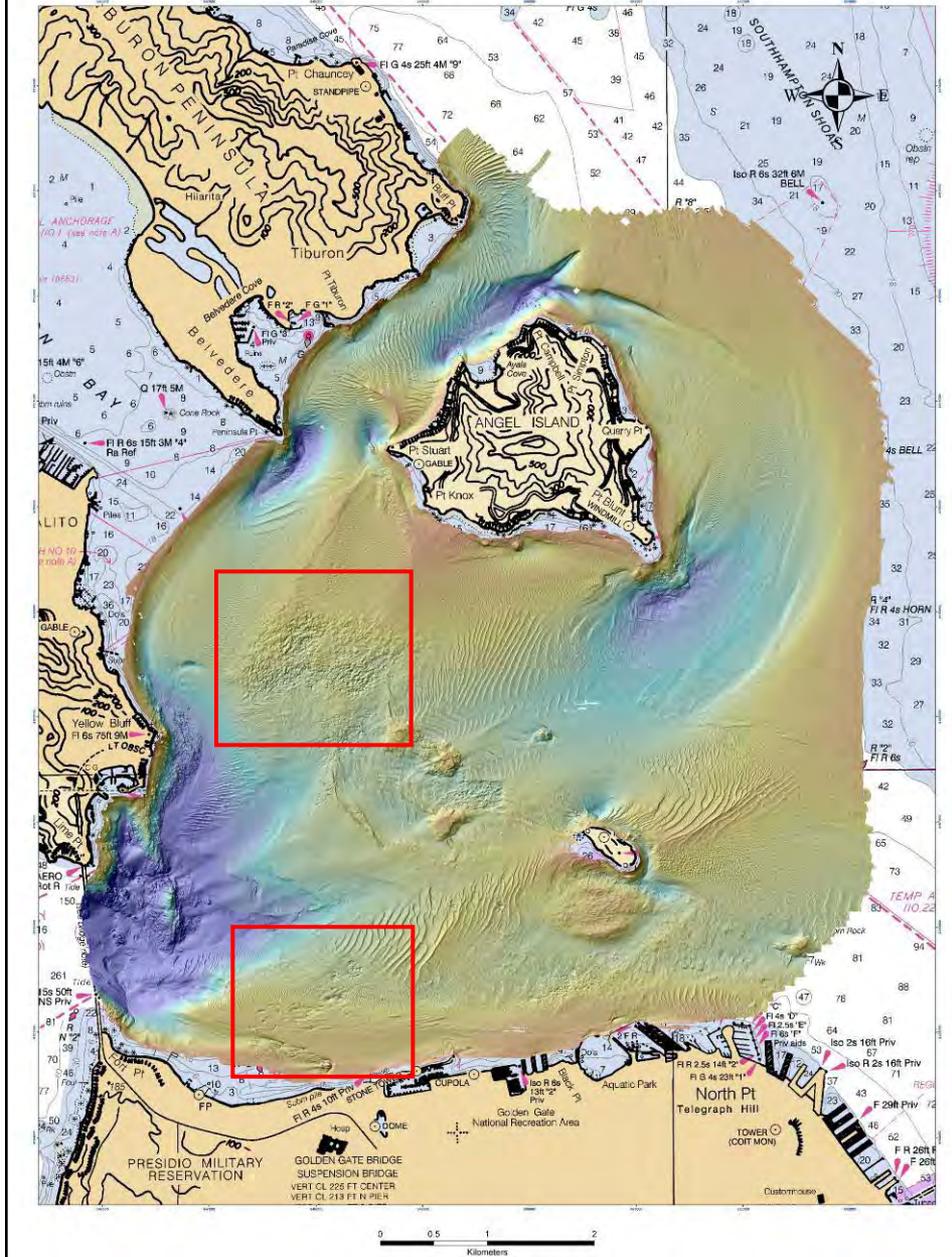
Western San Francisco Bay 2008



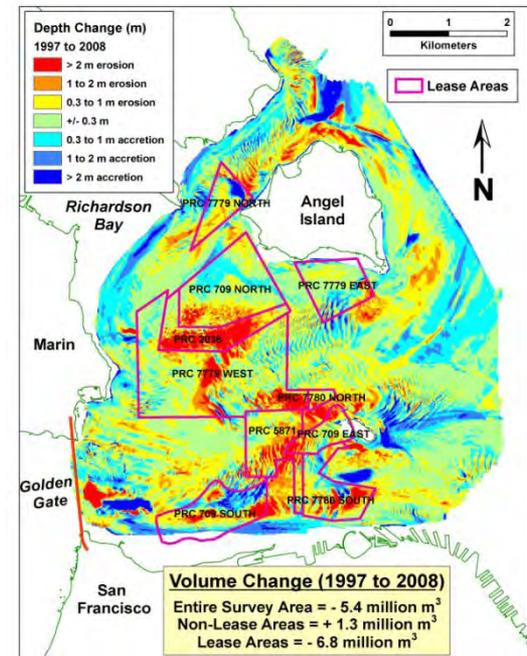
Quantification of Sandmining Activities



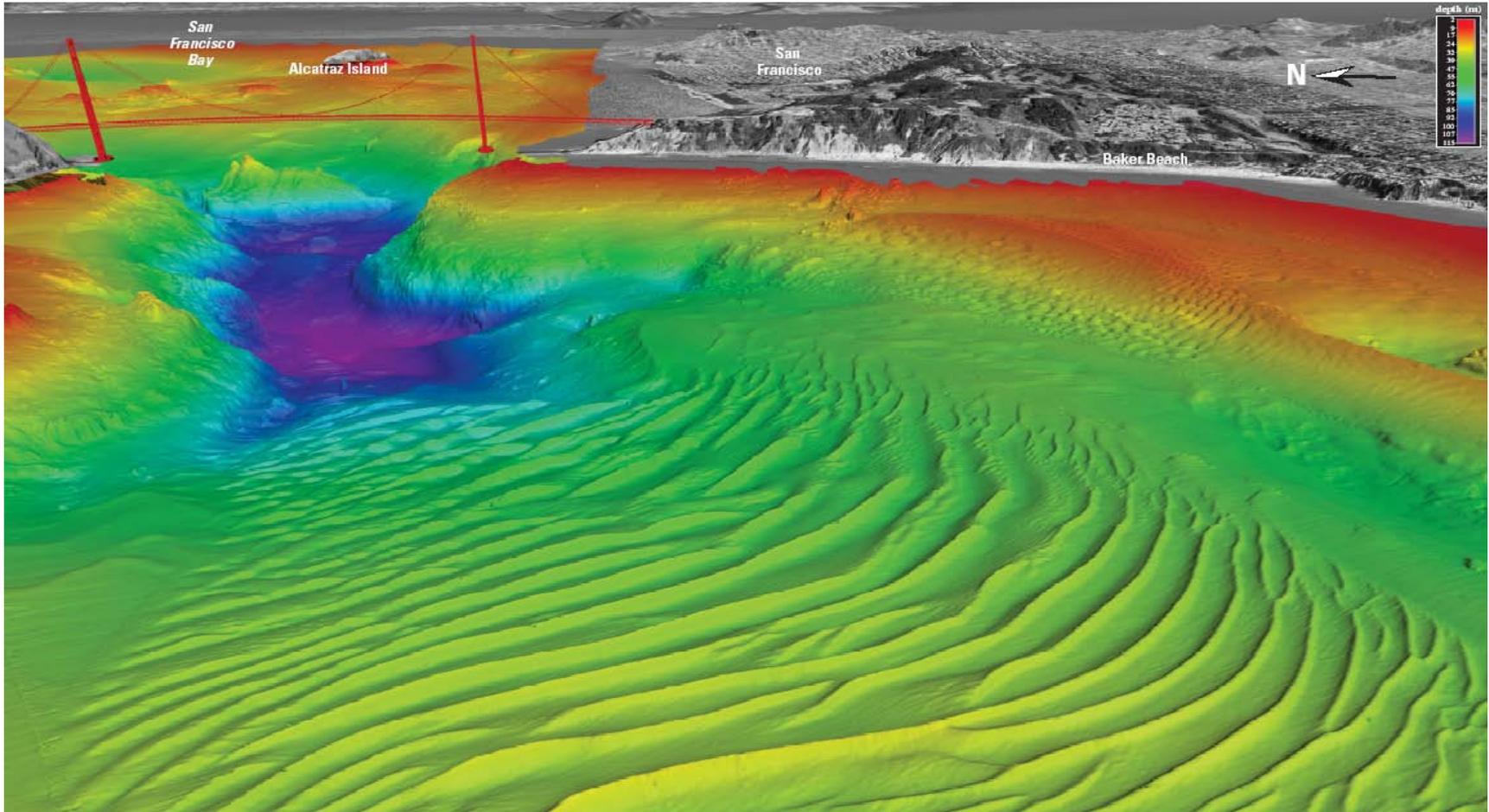
Western San Francisco Bay 2008



Quantification of Sandmining Impacts

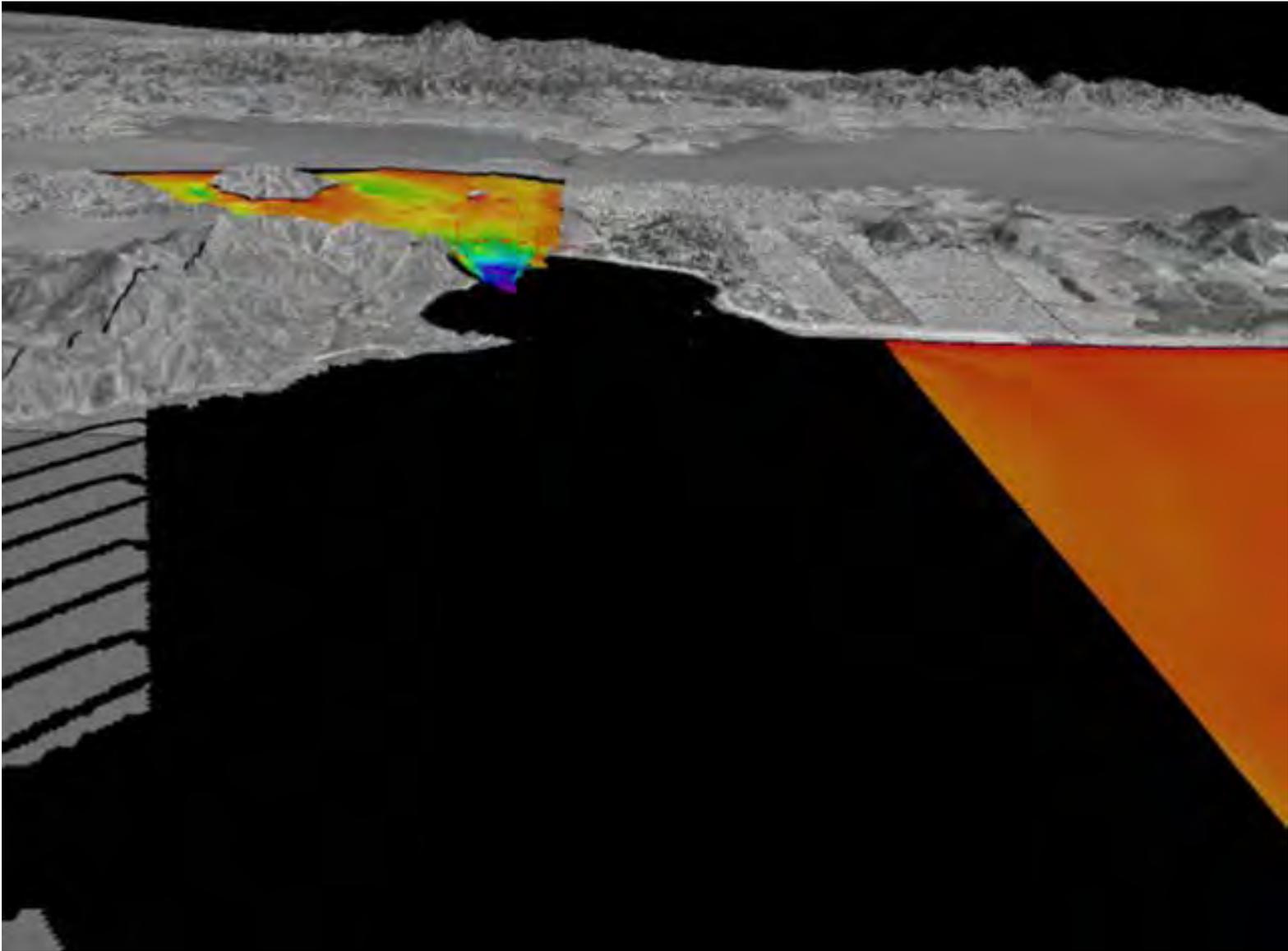


Migrating Dune Fields & Sand Transport

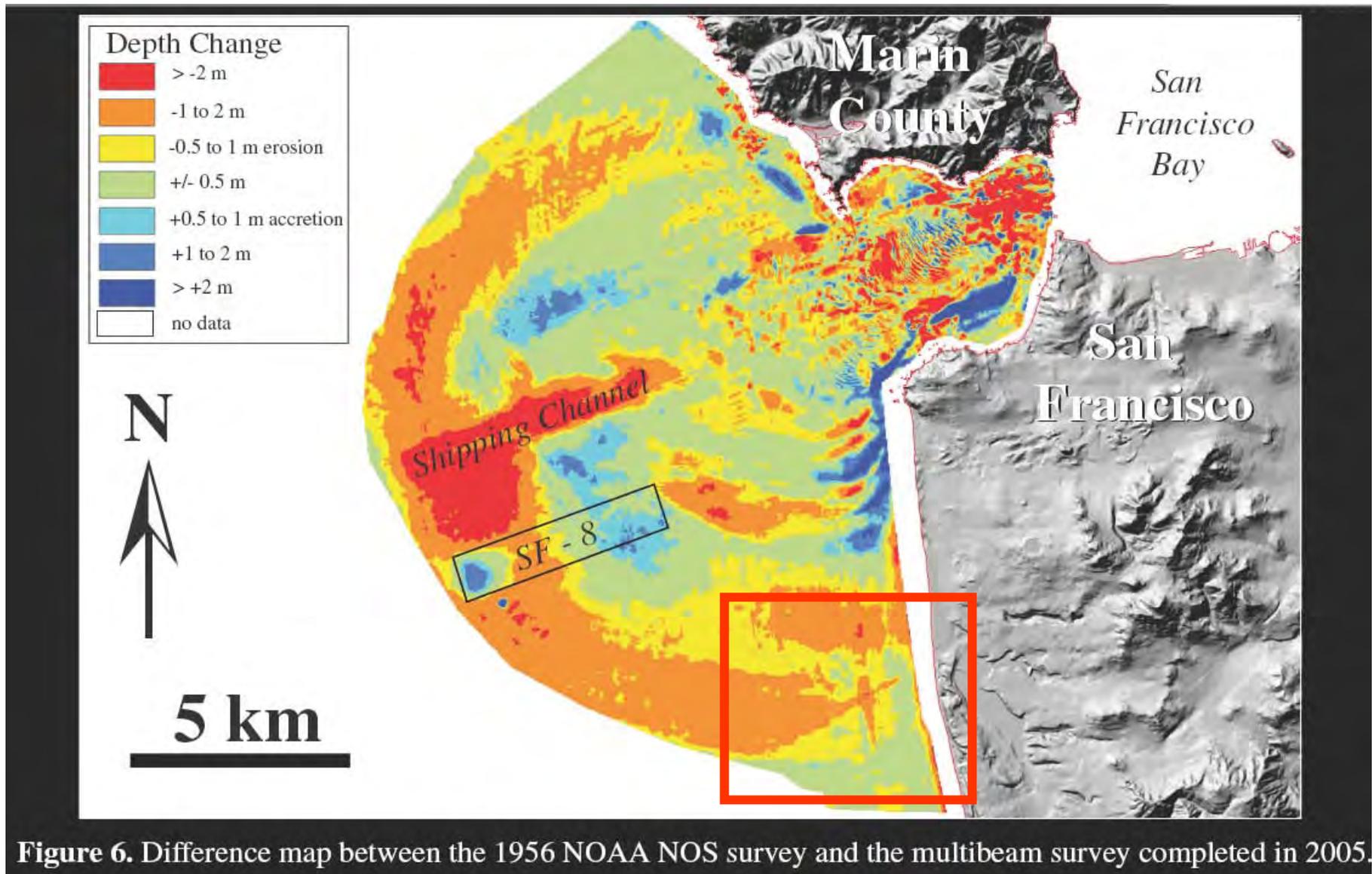


Modeling currents, sediment transport & coastal erosion

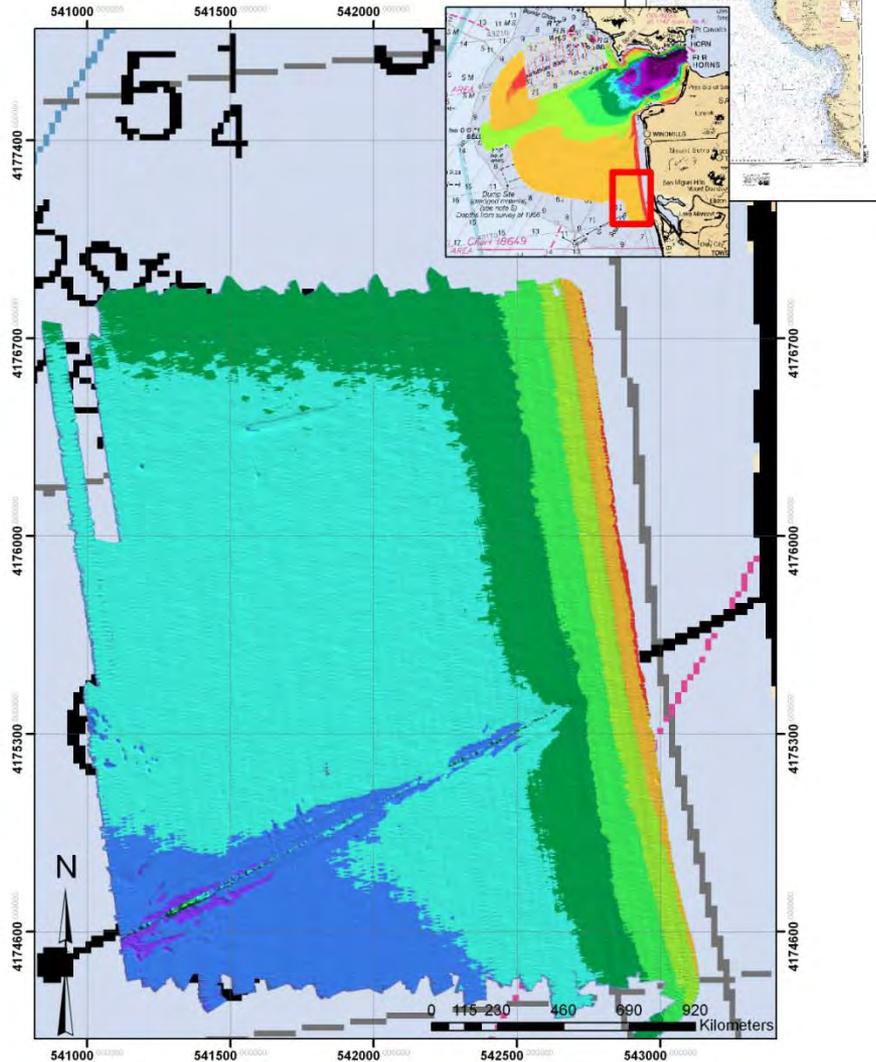
Maintaining SF Golden Gate & Ocean Beach



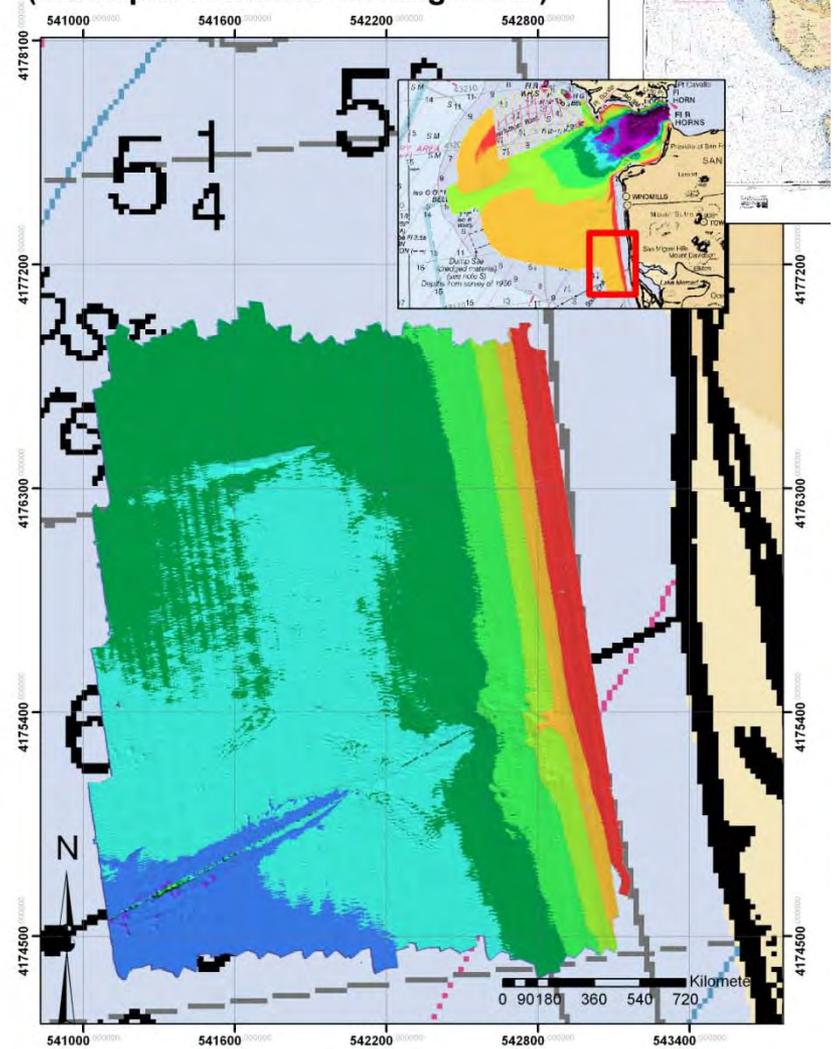
Changes at SF Bay Mouth Since 1956



Ocean Beach Dredge Site
Pre-Dredge: 5/16/05-5/17/05
(1m depth contours starting at 8m)



Ocean Beach Dredge Site
Post Dredge: 6/8/05
(1m depth contours starting at 8m)

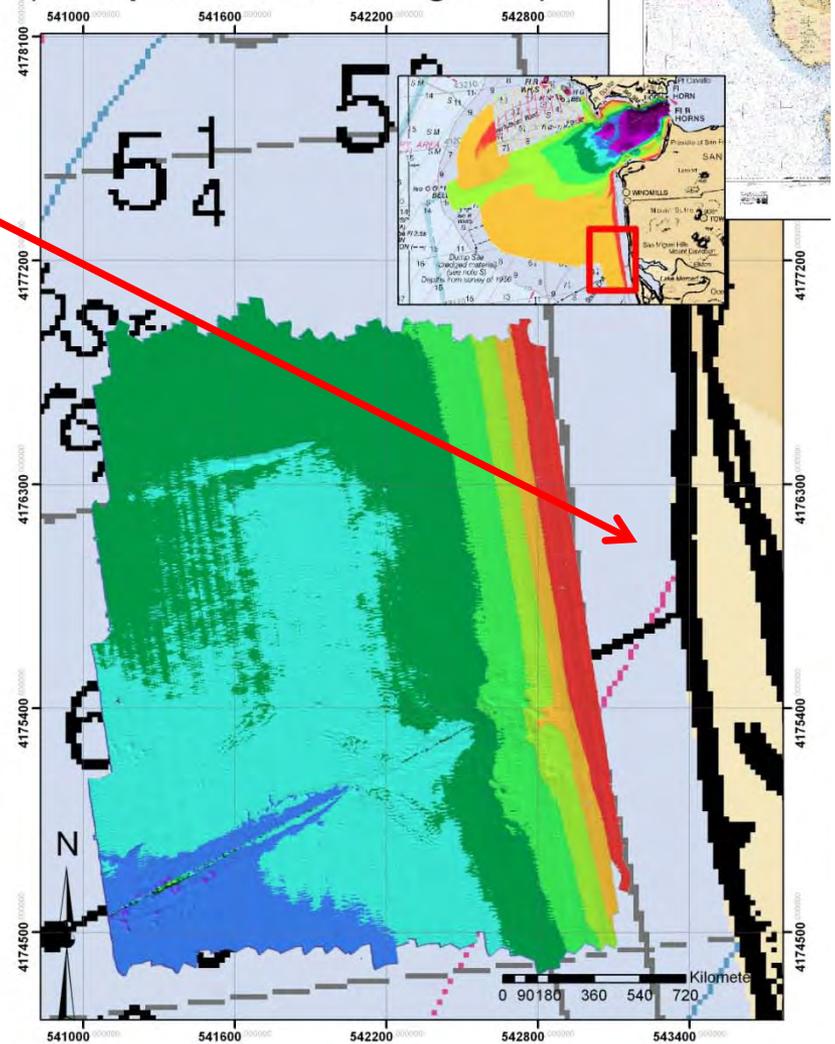


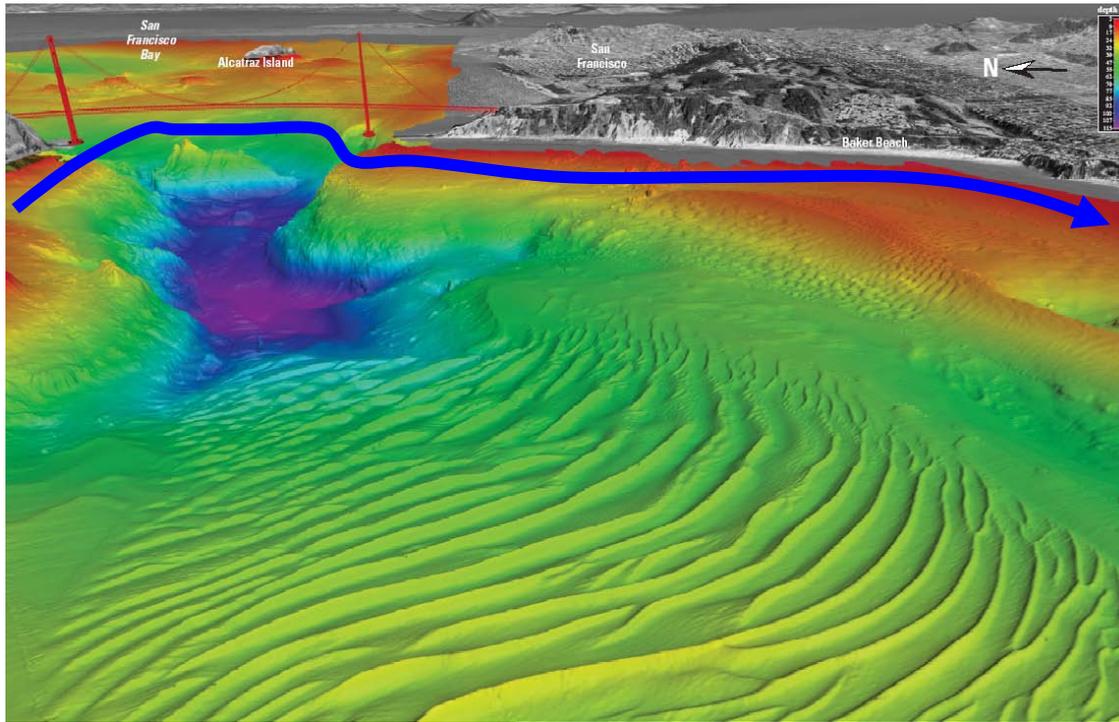
Great, but what about the beach?

LIDAR on a boat?!

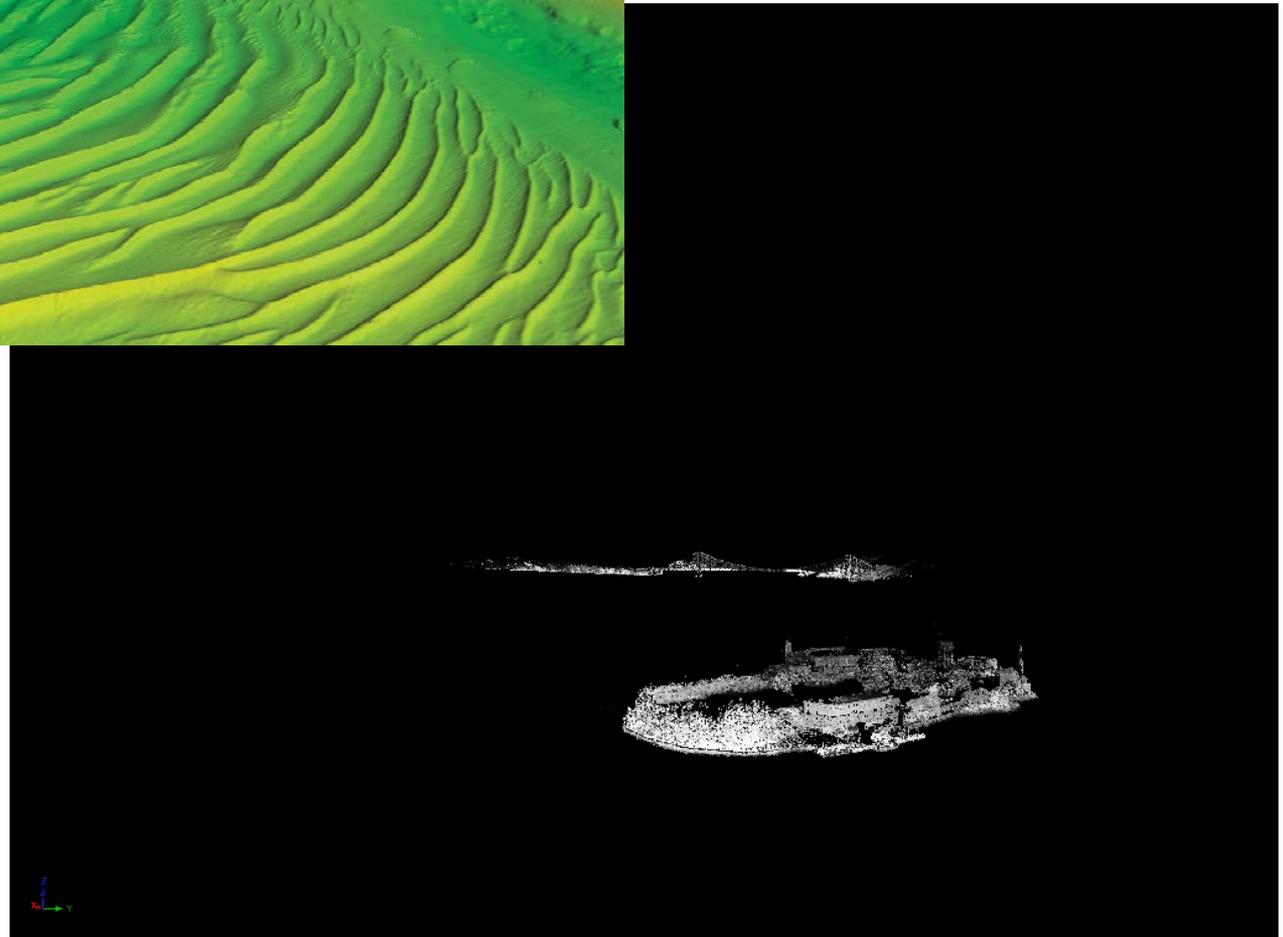


Ocean Beach Dredge Site
Post Dredge: 6/8/05
(1m depth contours starting at 8m)





Shoreline Mapping With Boat-mounted LIDAR





1998

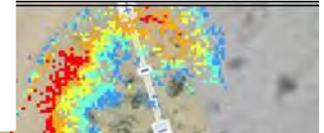


2008



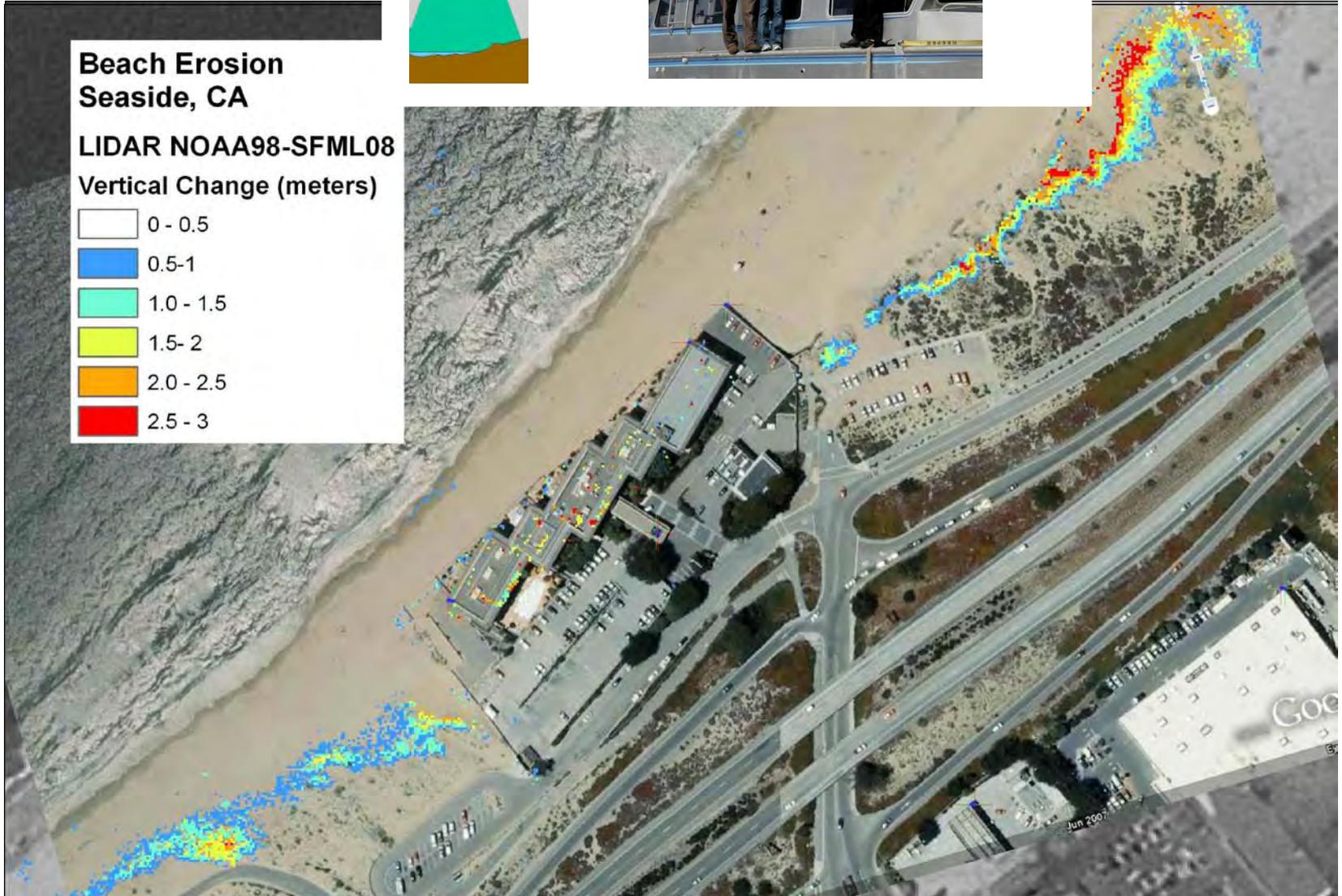
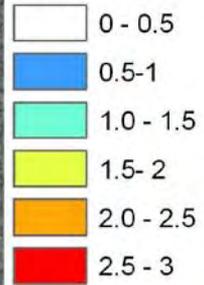
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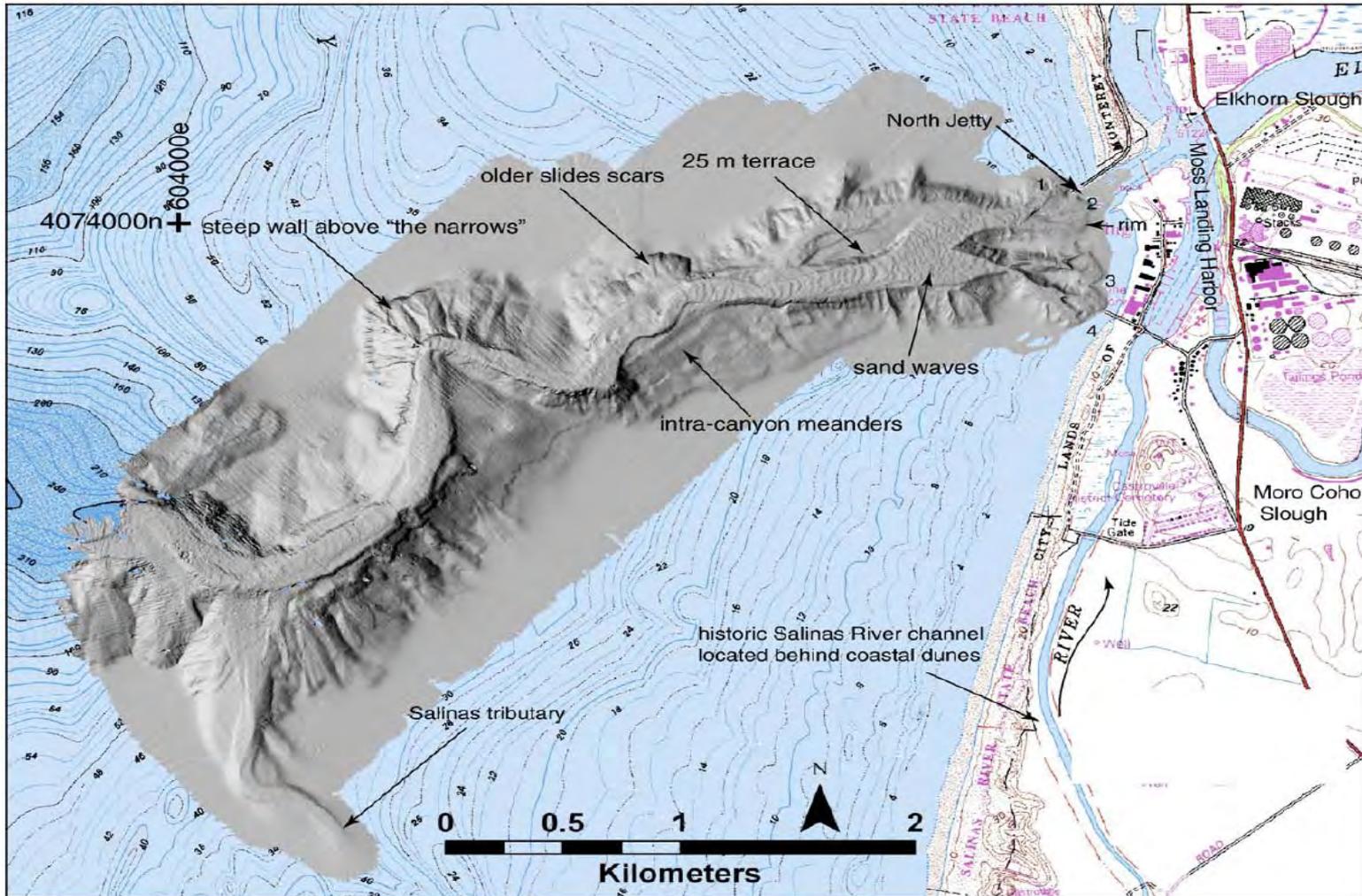


Beach Erosion Seaside, CA

LIDAR NOAA98-SFML08
Vertical Change (meters)

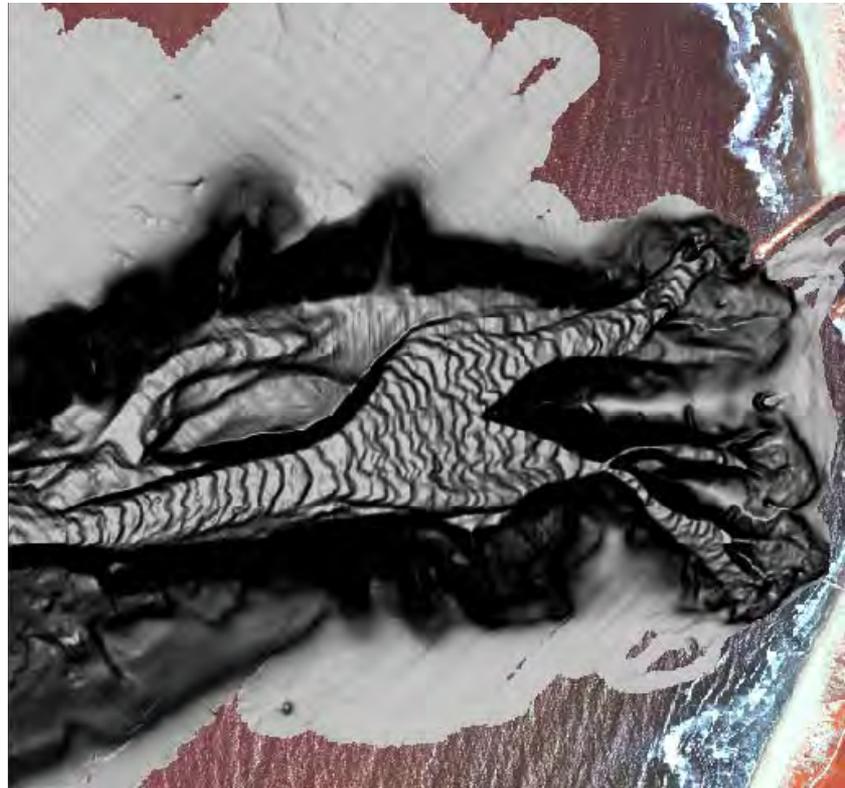


Base Map for Environmental Change Detection

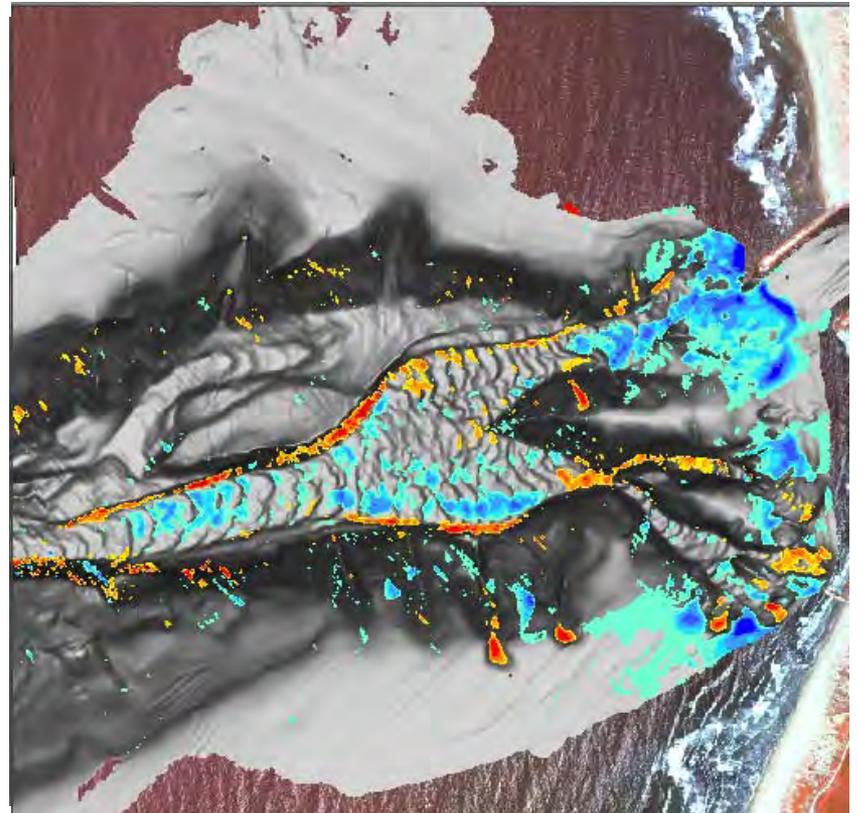


Repeat Mapping = Habitat Change Detection

Fall

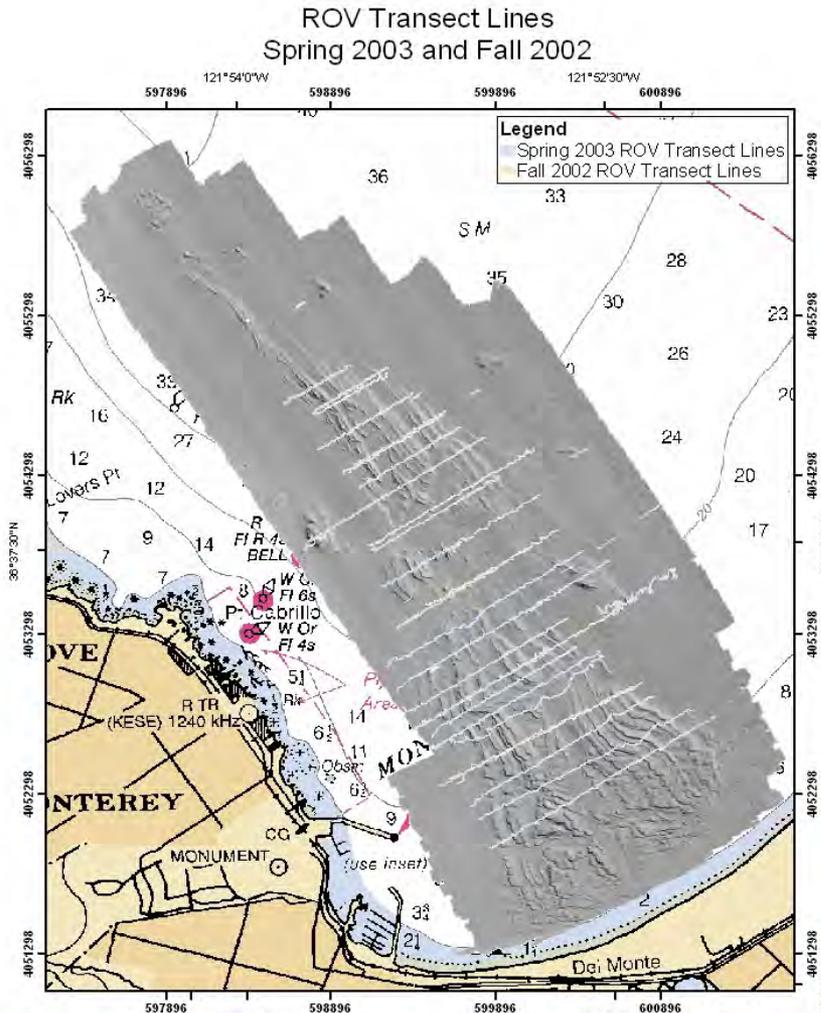


Spring

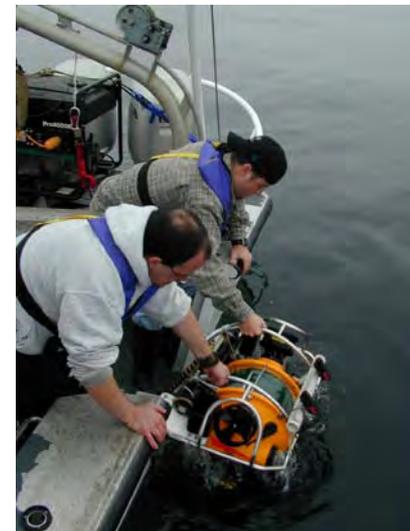
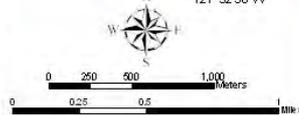




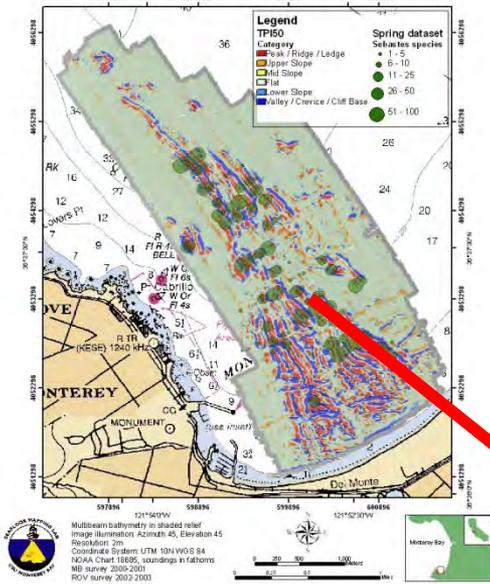
Species-Specific Habitat Maps for Fish Stock Assessments & MPA Suitability Modeling



Multibeam bathymetry in shaded relief
 Image illumination: Azimuth 45, Elevation 45
 Resolution: 2m
 Coordinate System: UTM 10N WGS 84
 NOAA Chart 18685, soundings in fathoms
 MB survey 2000-2001
 ROV survey 2002-2003



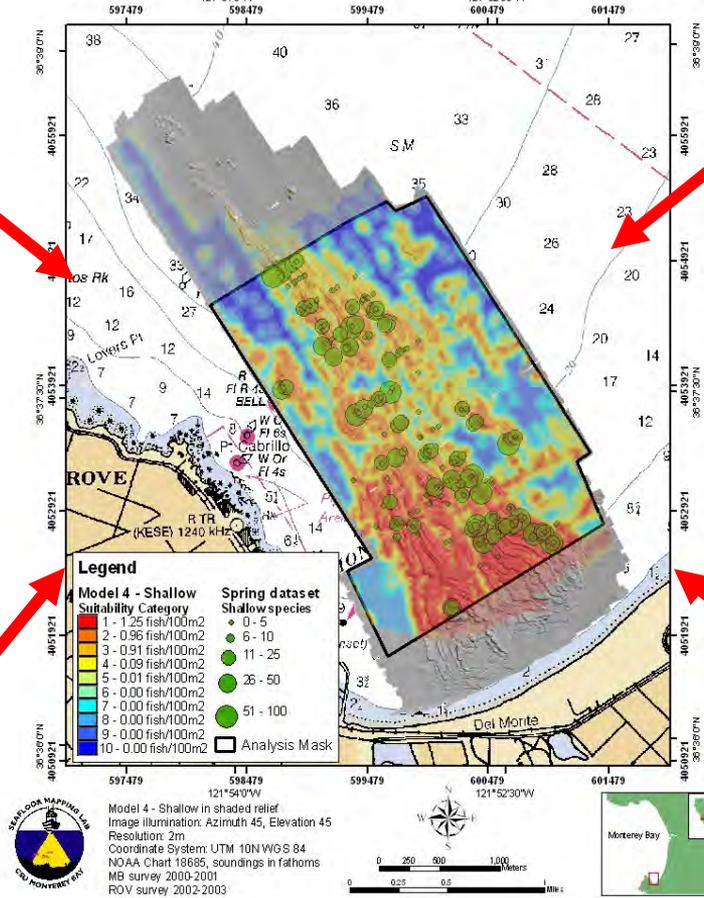
TPI₅₀ Analysis:
Spring *Sebastes* species distribution and abundance



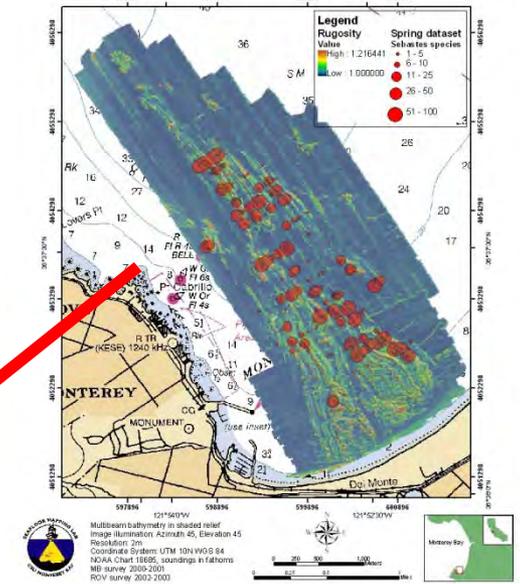
Predicted Fish Distribution

“Shallow” species model

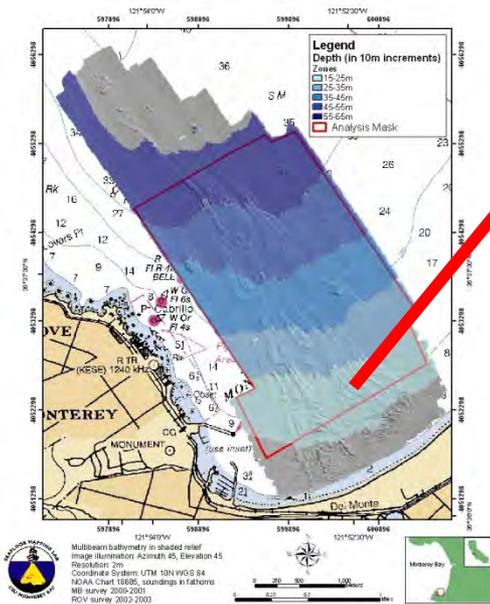
Model 4 - Shallow
Distance to Optimal - TPI₅₀ Peaks + Slope + Rugosity + Depth
Spring Dataset Distribution and Abundance: 2 *Sebastes* species



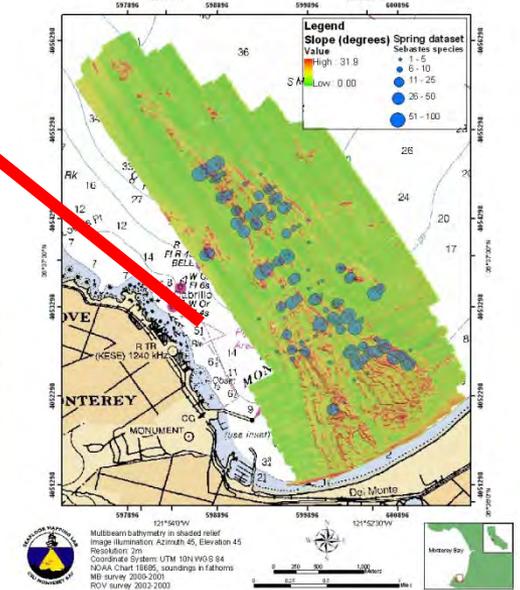
Rugosity Analysis:
Spring *Sebastes* species distribution and abundance



Depth Zones used in Habitat Suitability Models



Slope Analysis:
Spring *Sebastes* species distribution and abundance

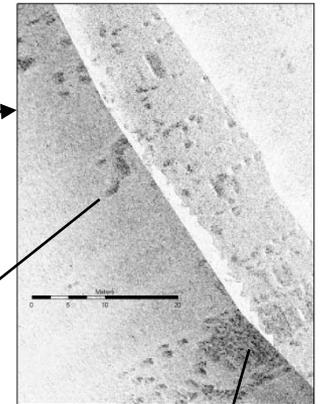
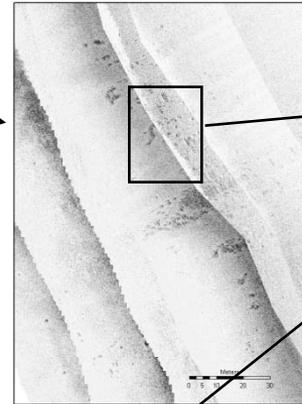
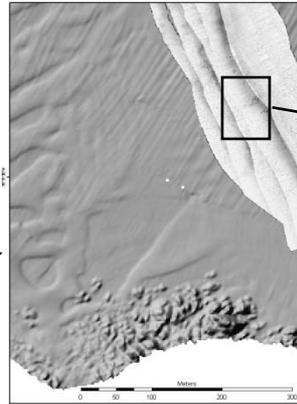
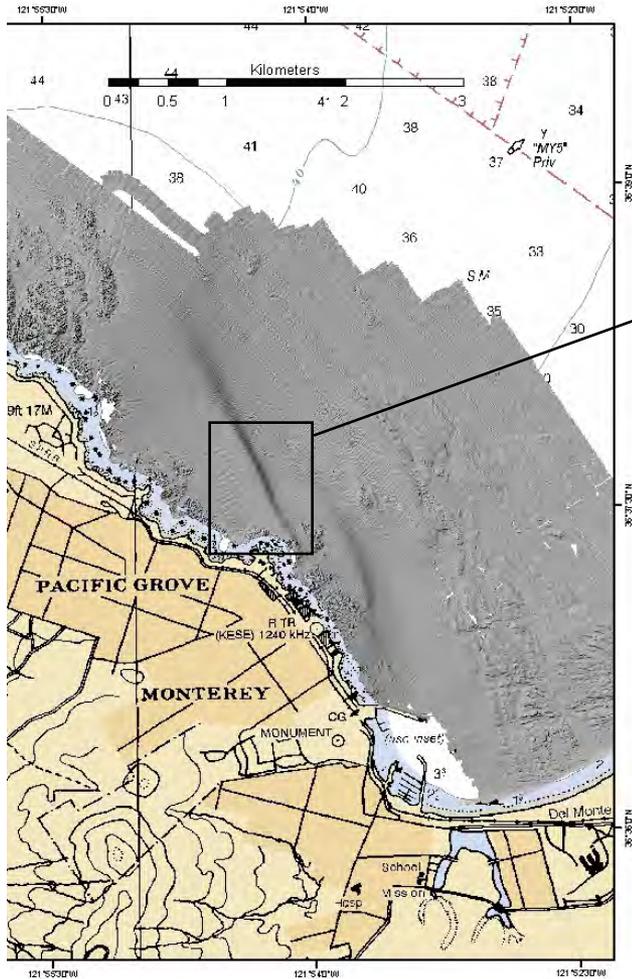


**Monitoring Reproductive Effort
&
Spawning Success**

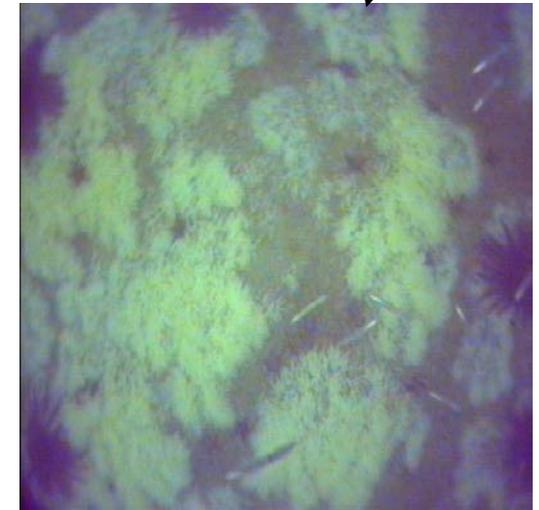
How to make market squid the ideal sustainable fishery.



Sidescan sonar monitoring squid egg production

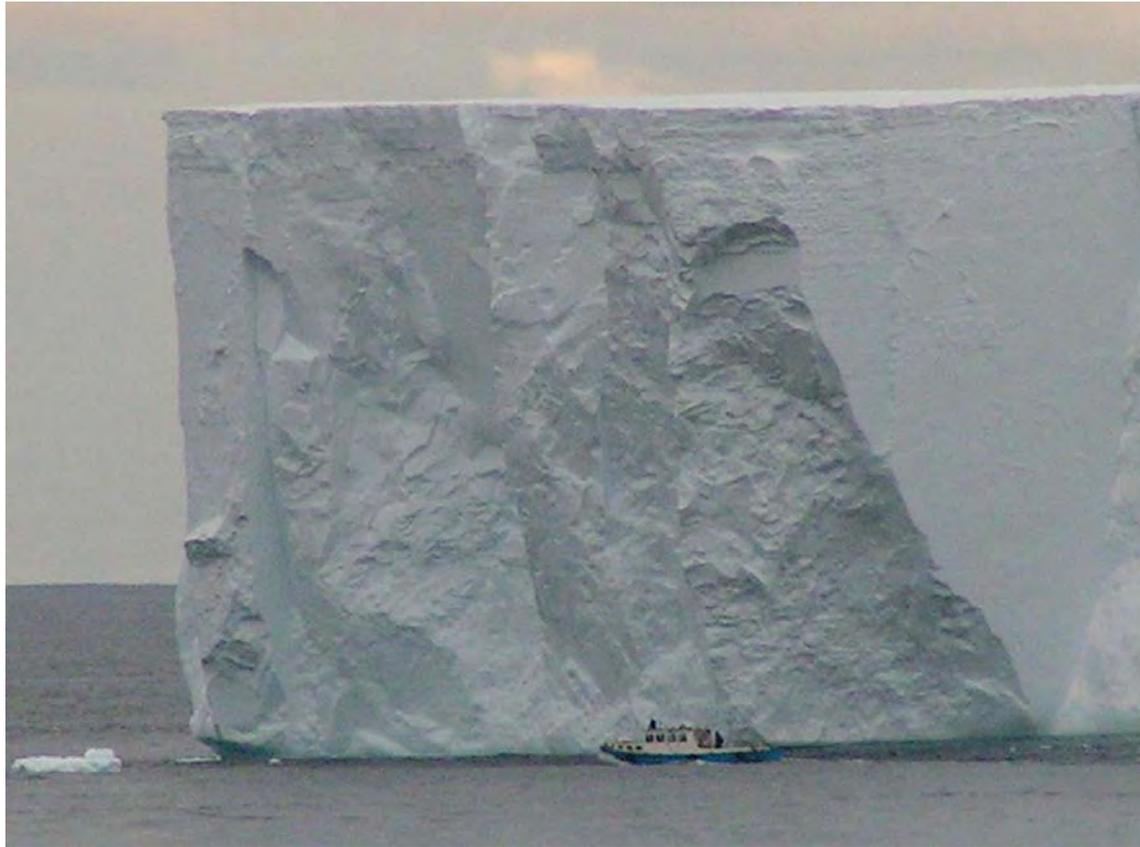


Small egg mop cluster

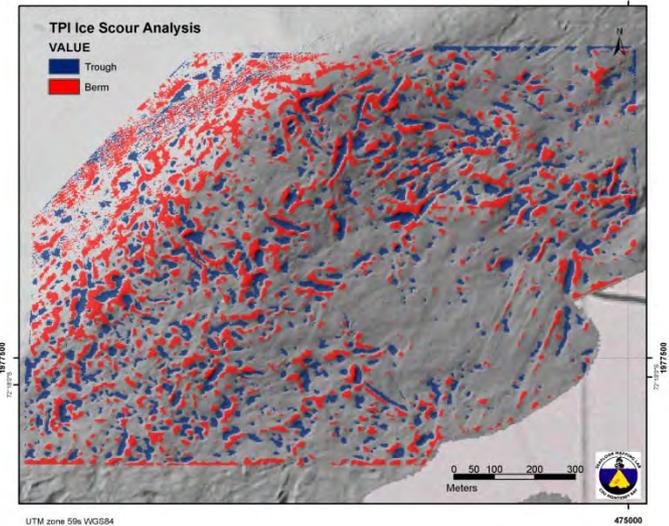
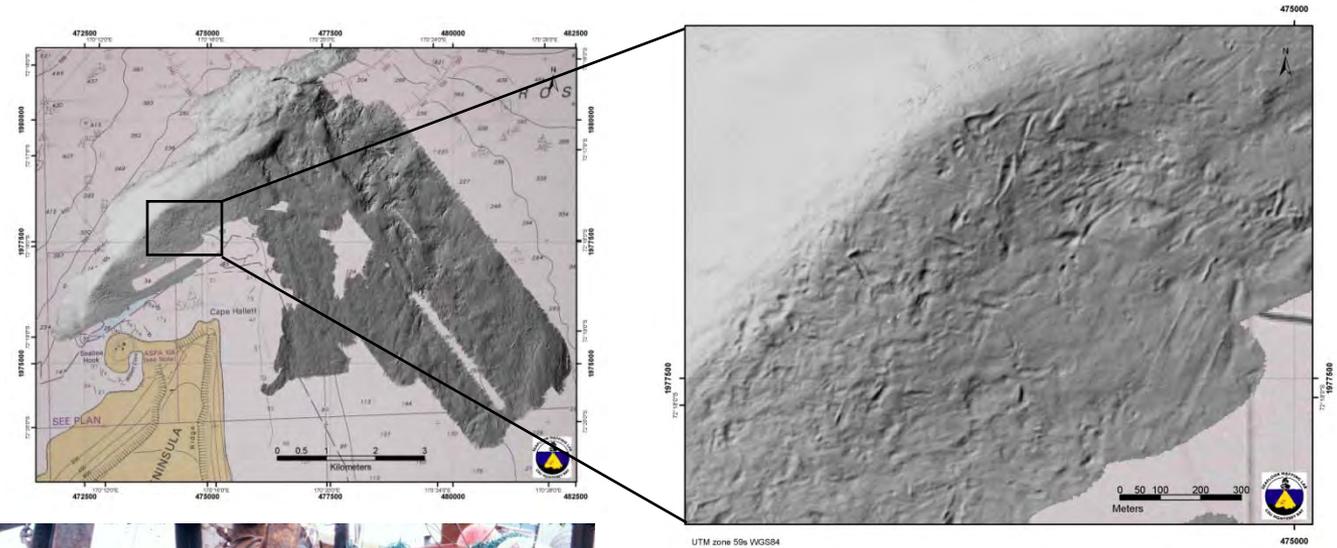


Large egg mop aggregation

Monitoring habitat disturbance

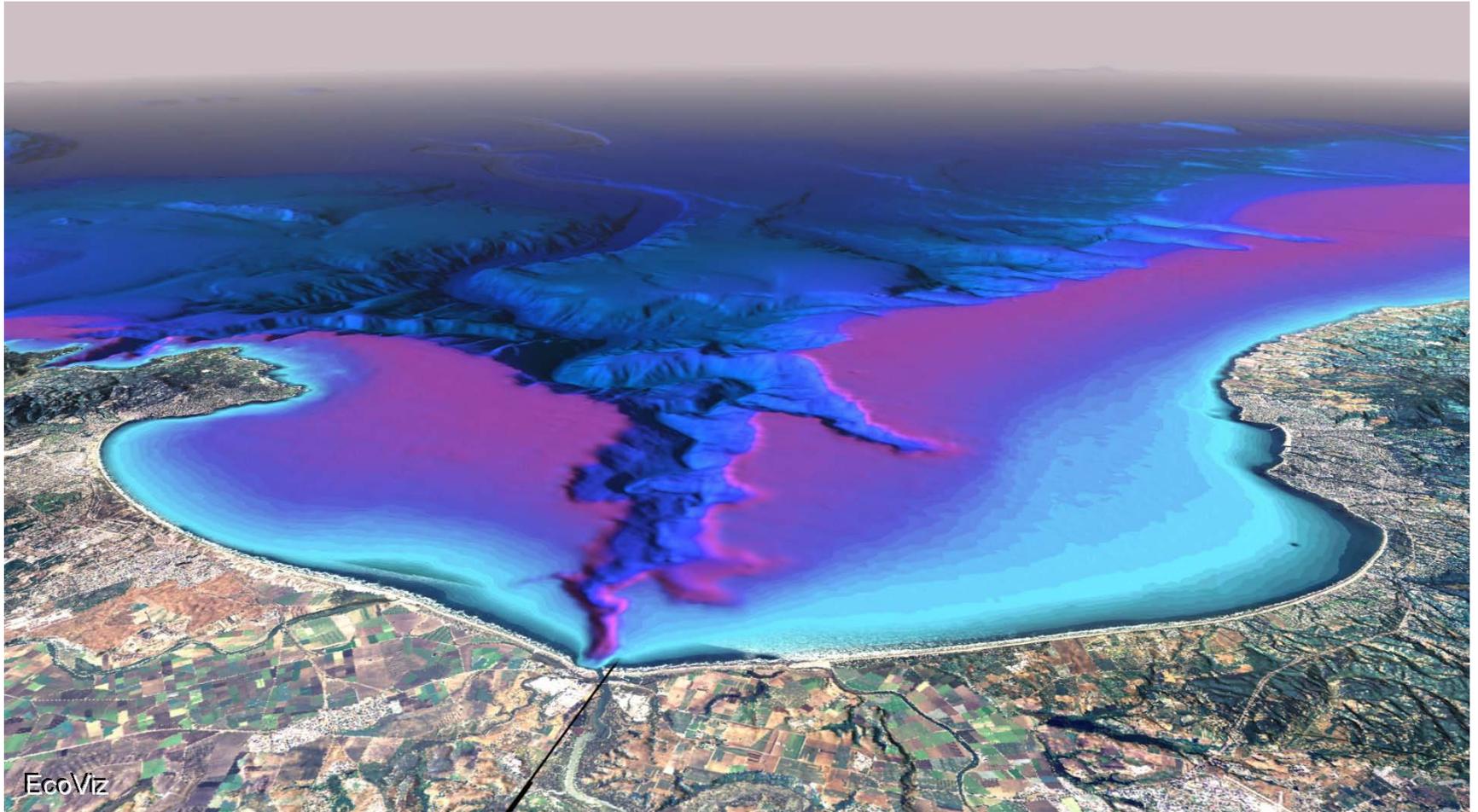


Quantifying seafloor disturbance



	Area (m ²)	% Area
Trough	175056	12.72%
Berm	223400	16.23%
Total Scour	398456	28.95%
Total Survey	1376328	

So, how far along is the CSMP and when will the data be available?

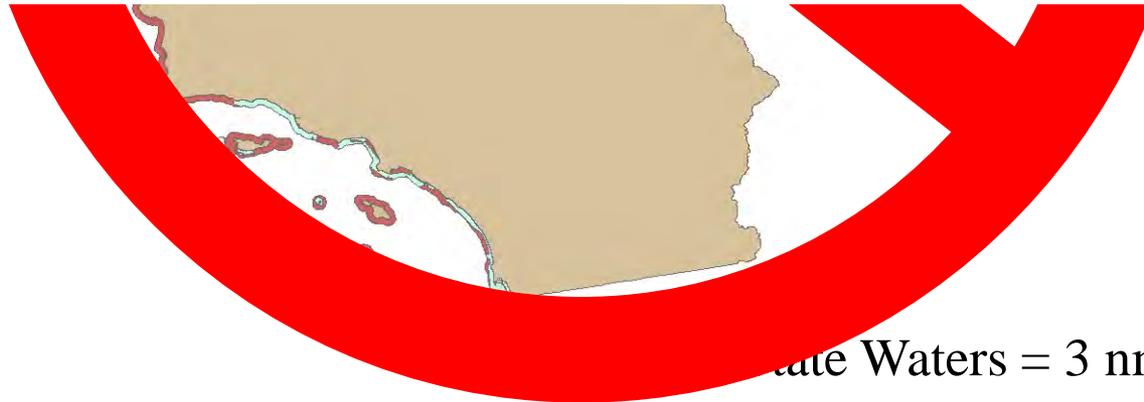


California State Water Mapping Project Launched Spring 2008

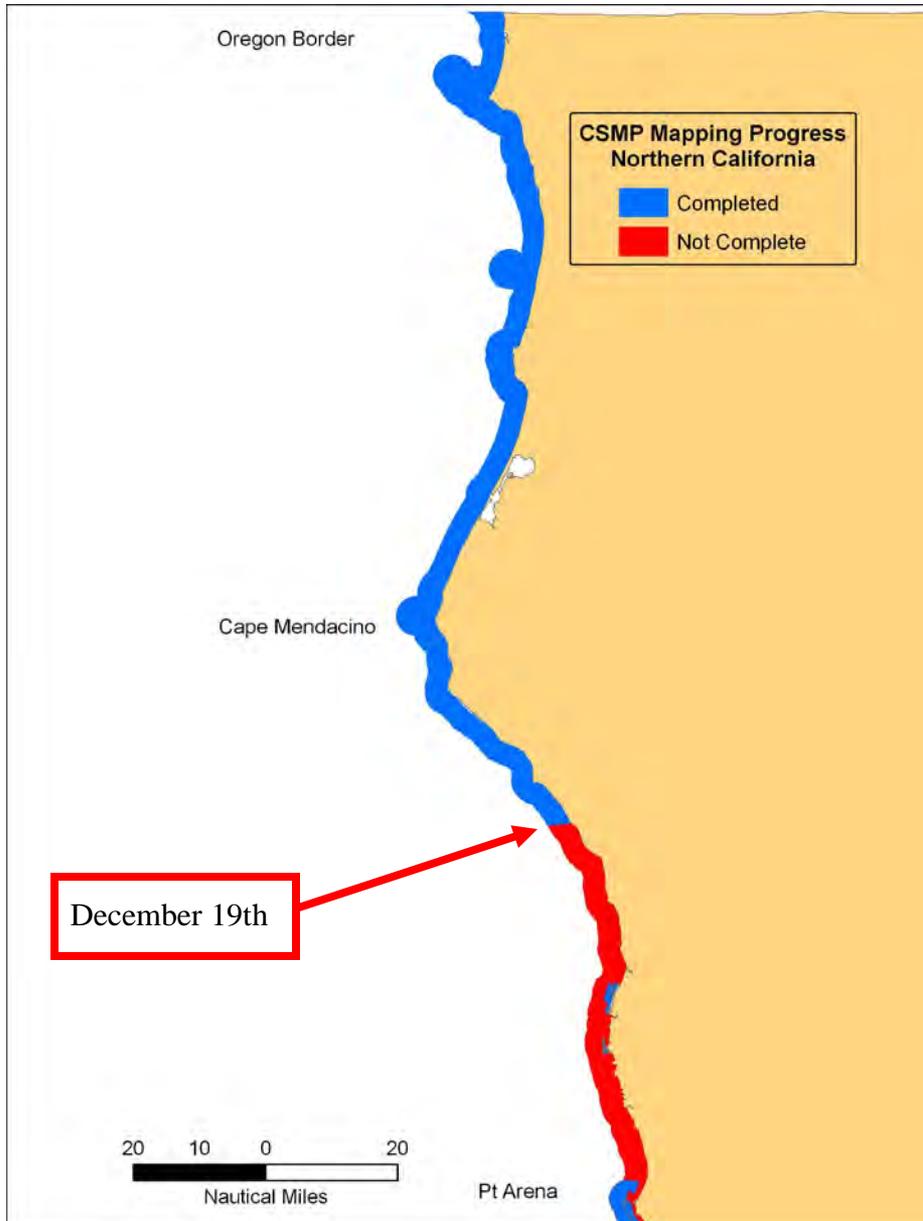


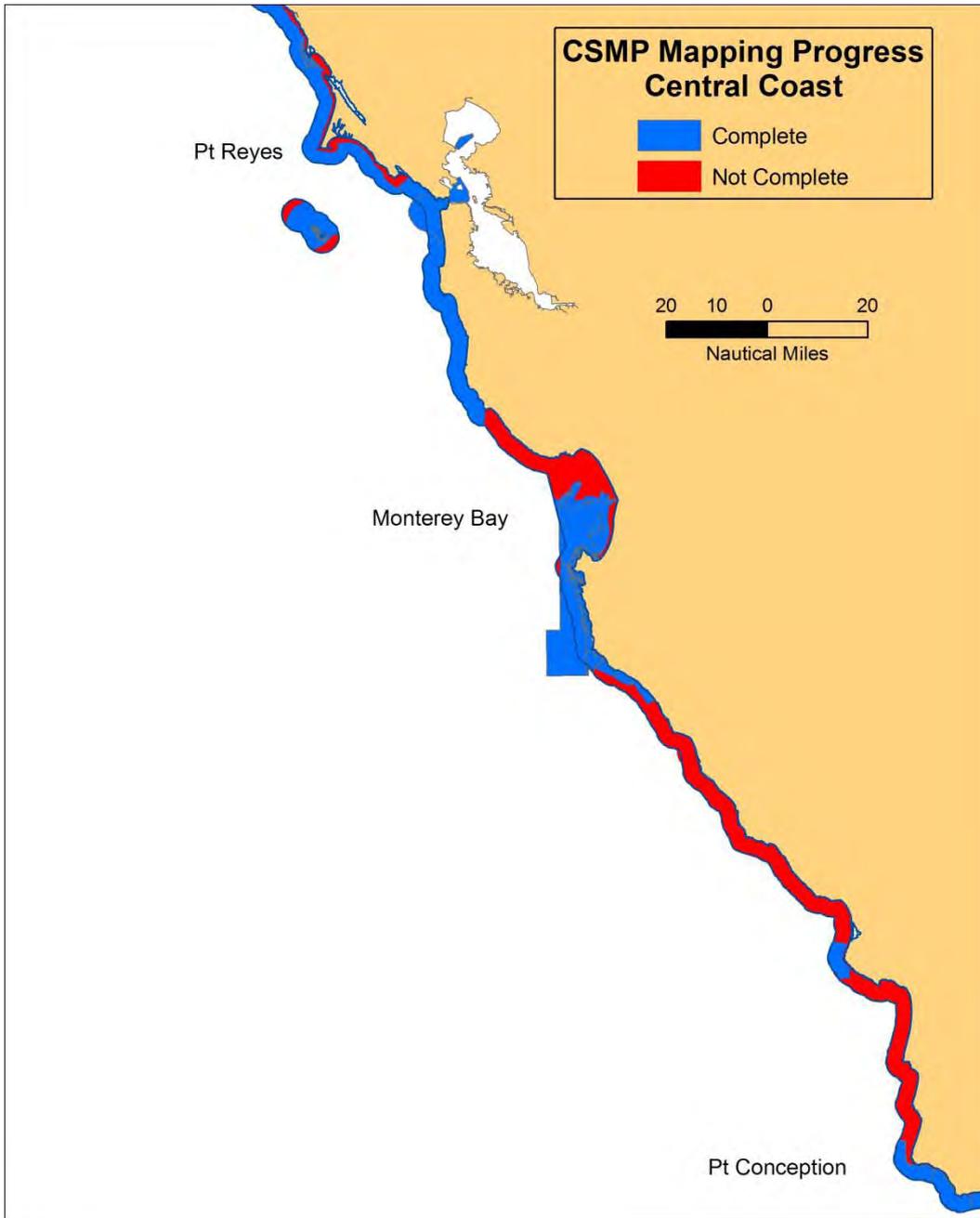
December 19, 2008

All California State Bond Projects Halted



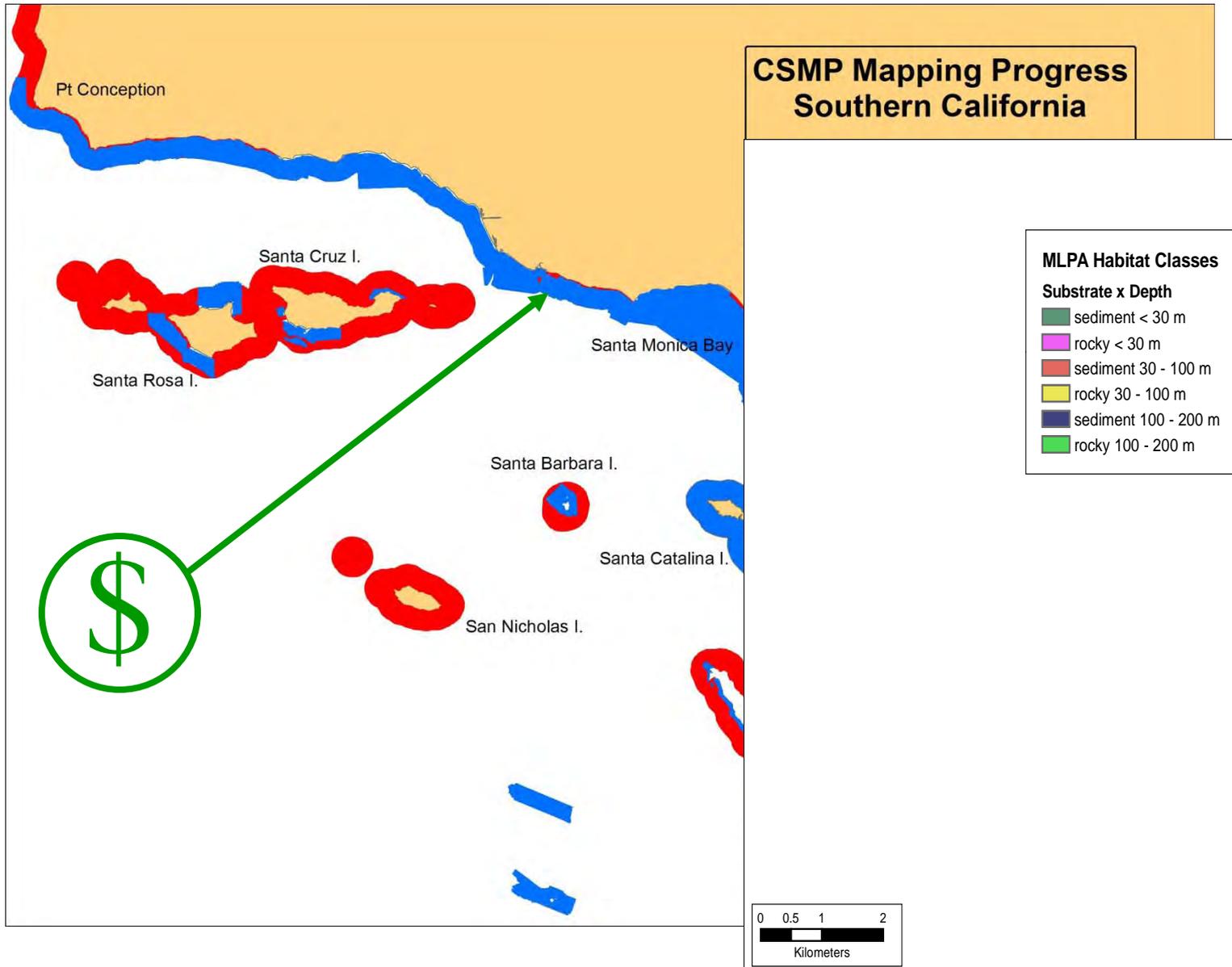
North Coast Progress





Central Coast Progress

Southern California Progress





That's why these students are smiling.

A map of California is shown in the background, colored in a light tan or beige. Overlaid on the map is a large red prohibition sign, consisting of a thick red circle with a diagonal slash from the top-left to the bottom-right. The text is centered within this sign.

But for now:

**No New CSMP Data
Acquisition**

**No new data products except
So Cal MLPA minimum**

Until State Bond Project Stop Work Order is Lifted



<http://seafloor.csumb.edu>

To access available data products