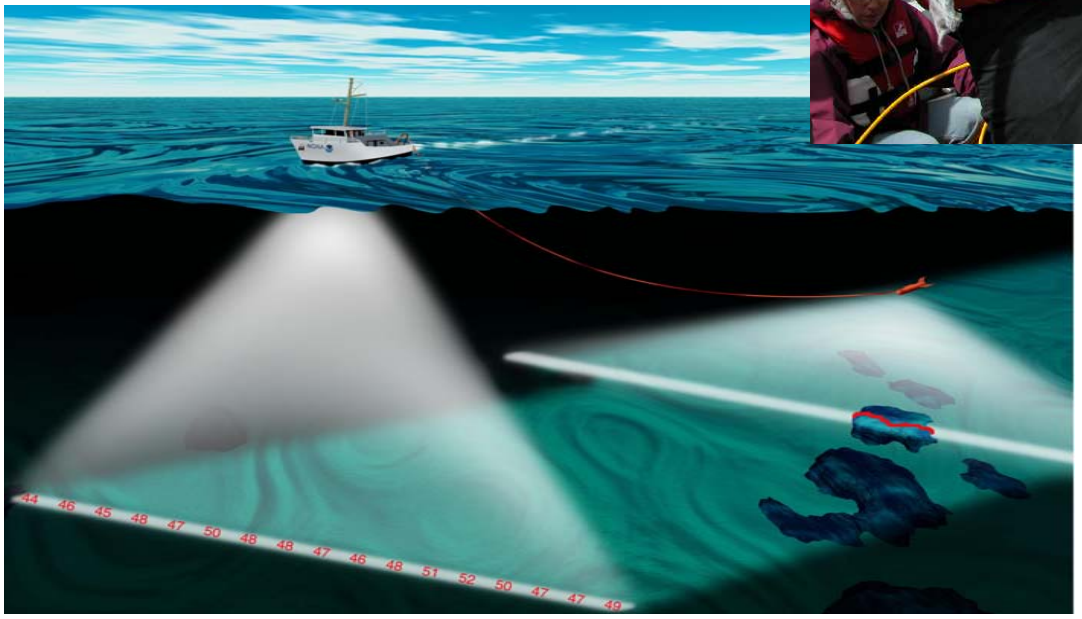
Rikk Kvitek – Division of Science & Environmental Policy
California State University, Monterey Bay

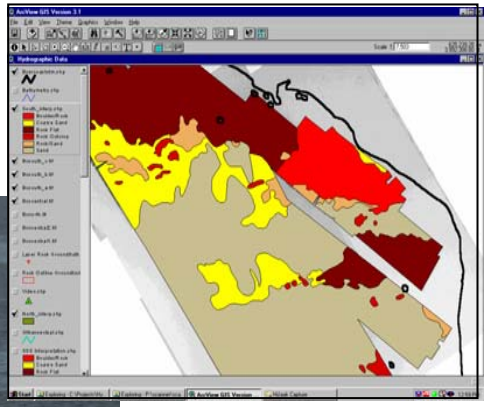


Student-Powered Research Promotes Hands-on-Learning In Geospatial Technology

CSUMB Seafloor Mapping Lab

Habitat Data Acquisition, Analysis & Display

Sidescan Sonar



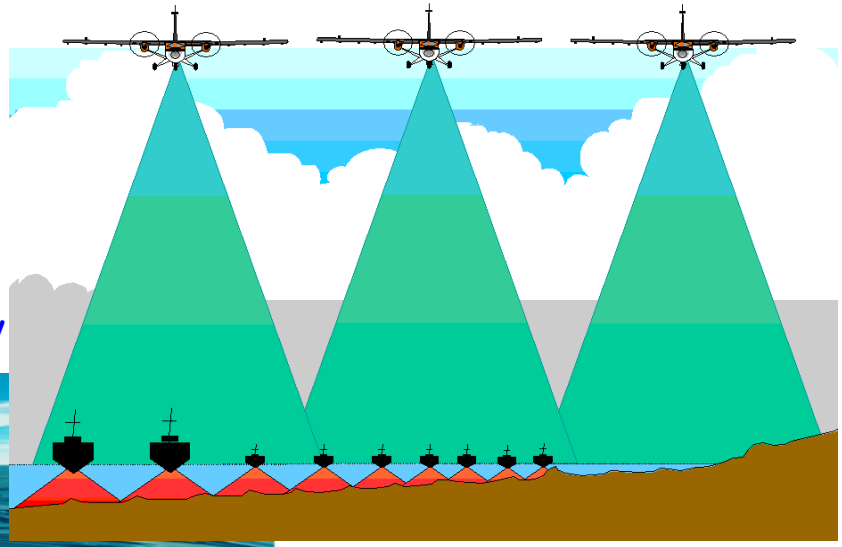
GIS Processing

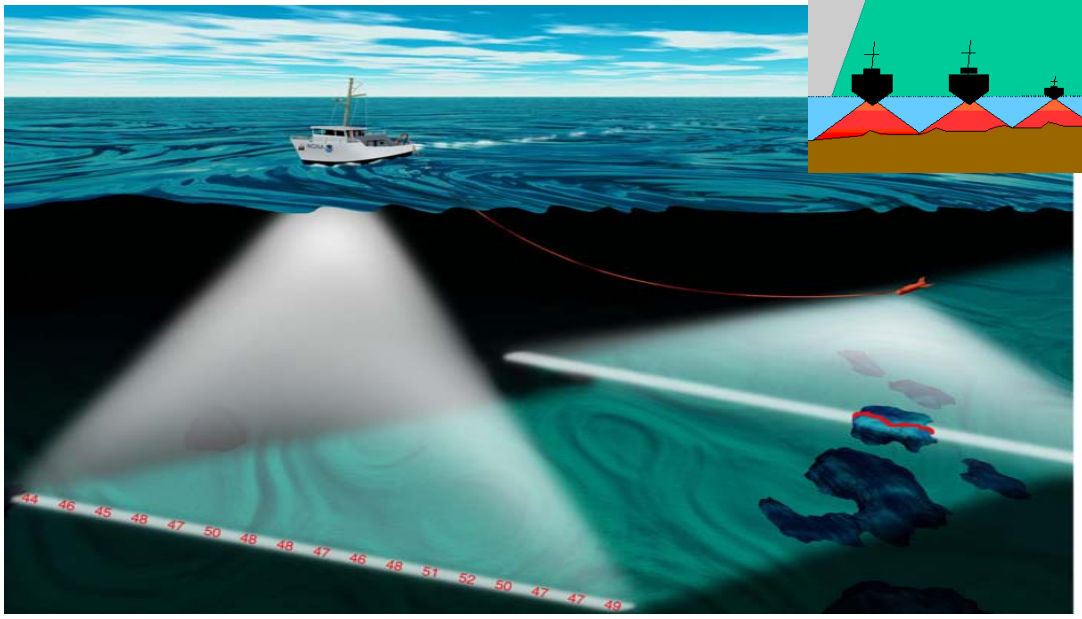
Multibeam Bathymetrey

Underwater video mapping

California State Water Seafloor Mapping Campaign: Progress report on a collaborative approach

Rikk Kvitek
CSUMB Seafloor Mapping Lab
Guy Cochrane – USGS
Edward Saade – Fugro Pelagos, Inc.
Gary Greene – Moss Landing Marine Labs
Chris Wills – California Geological Survey
Sheila Semans – California Coastal Conservancy



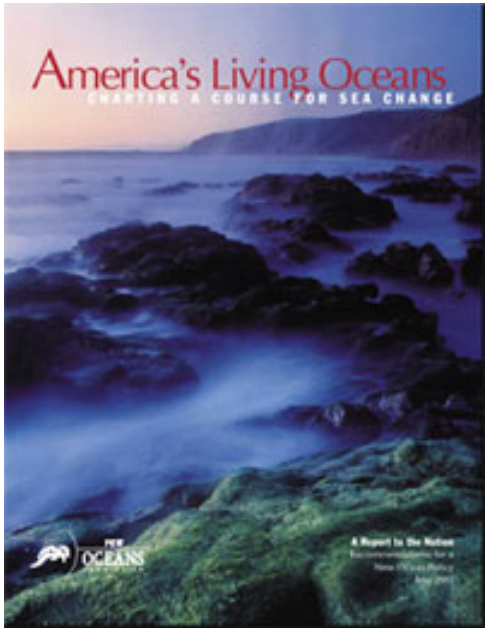


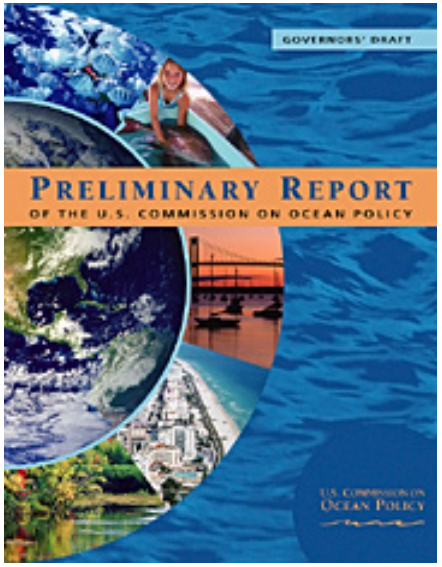
California Seafloor Mapping – why bother?

Federal Ocean Commission Reports
Recommending Ecosystem-Based Management

PEW OCEANS COMMISSION

The U.S. Commission on Ocean Policy



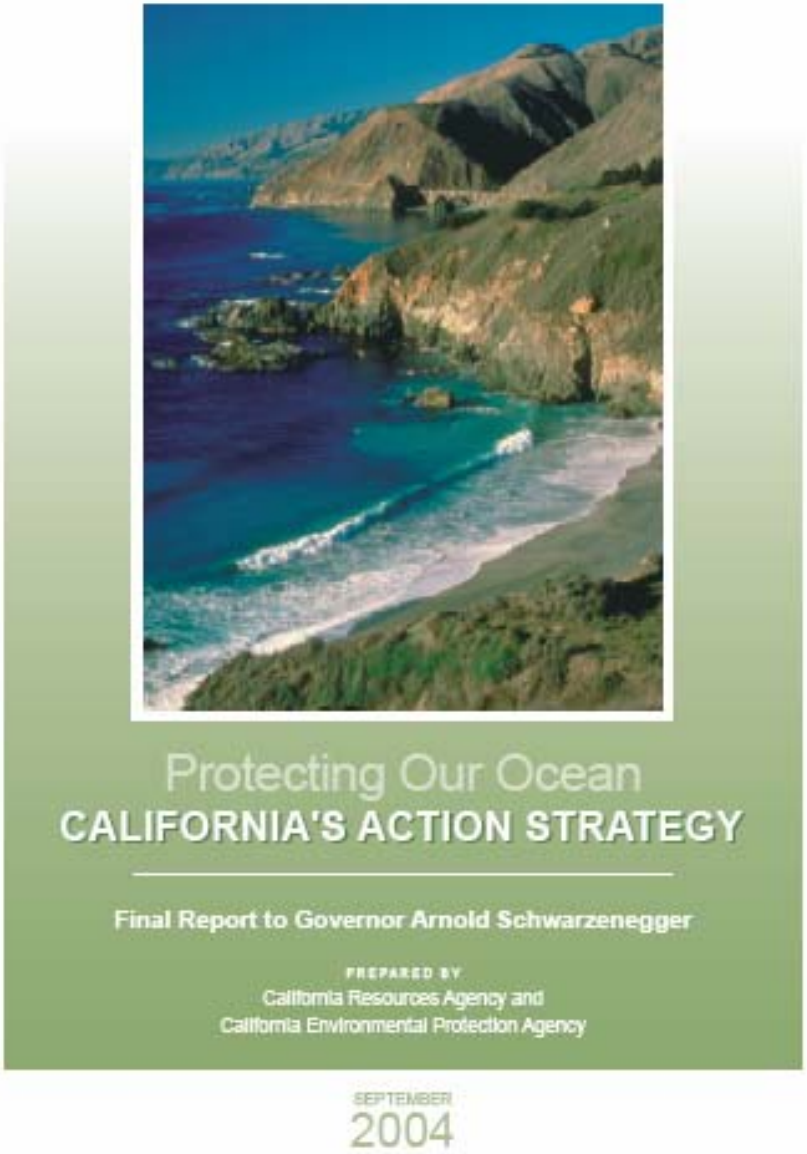


Sustainable Fisheries Amendment
to the Magnuson-Stevenson Act

Required NMFS to Identify and Manage for
Essential Fish Habitats

Marine Life Management Act

Required California to adopt an
Ecosystem Approach to Fisheries Management

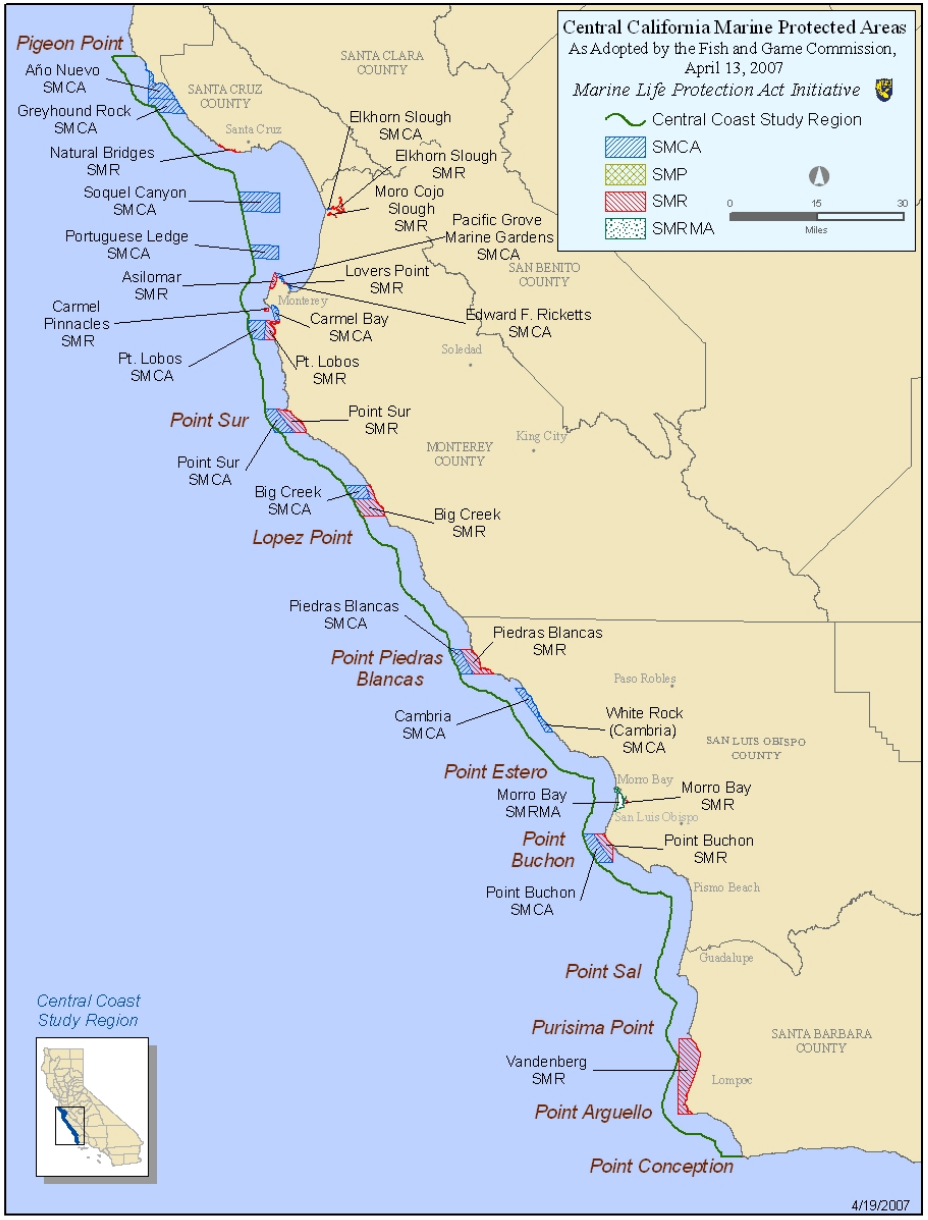


Governor's Ocean Action Strategy

Implementation of MLPA Initiative

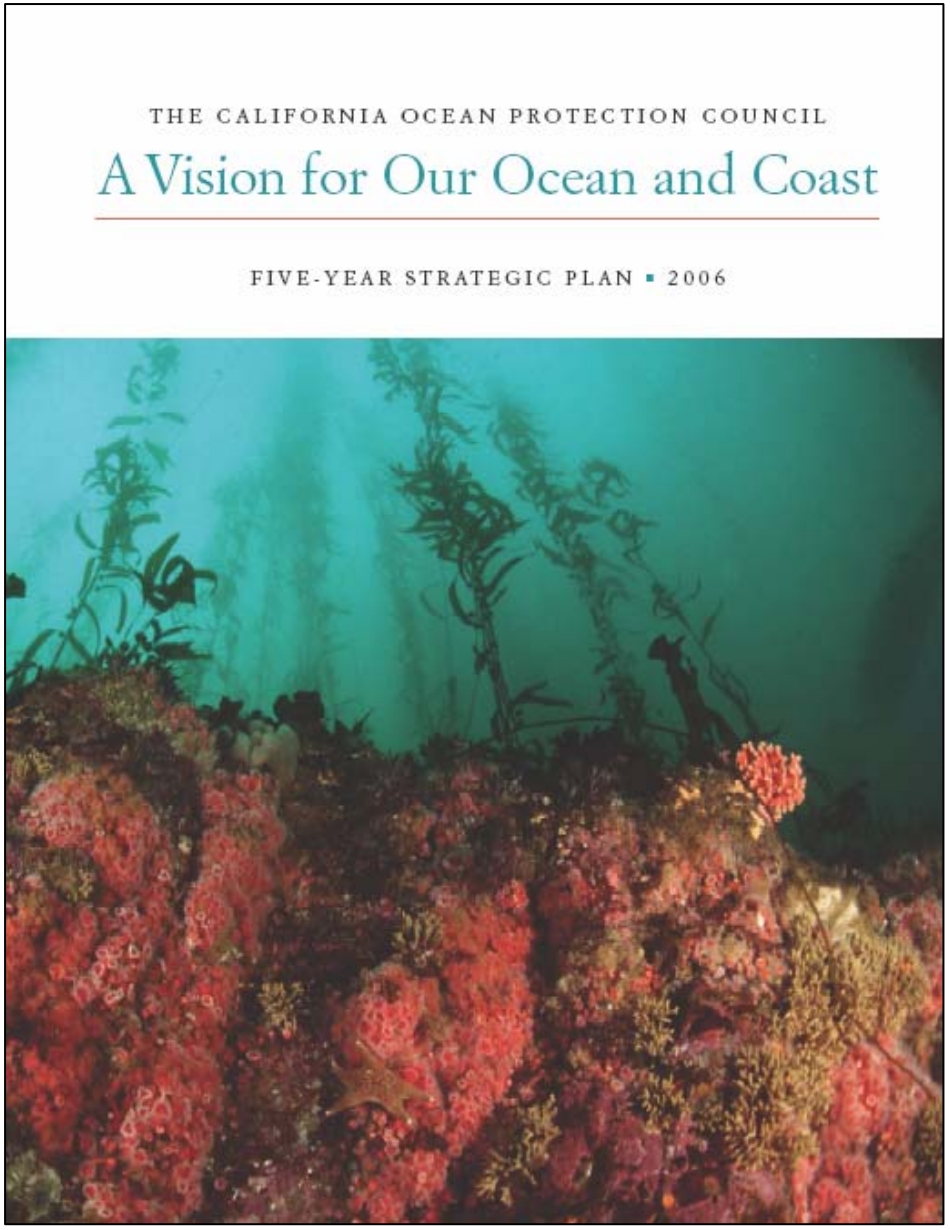
Marine Life Protection Act

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



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

Central California Marine Protected Areas
As Adopted by the Fish and Game Commission, April 13, 2007
Marine Life Protection Act Initiative
Central Coast Study Region
SMCA
SMP
SMR
SMRMA
0
15
30
Miles

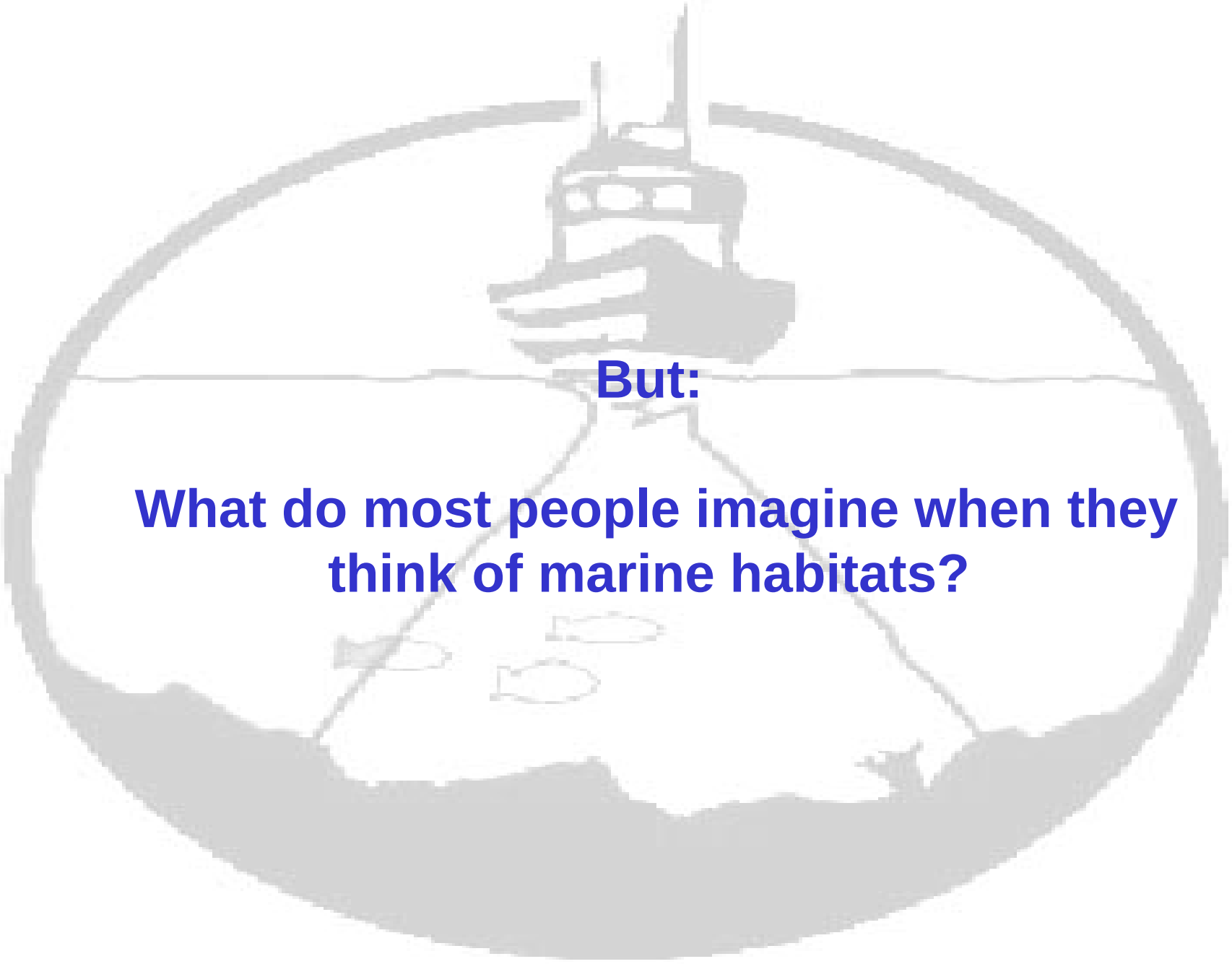


California Ocean Protection Council
Strategic Plan

Coastal Conservancy

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:

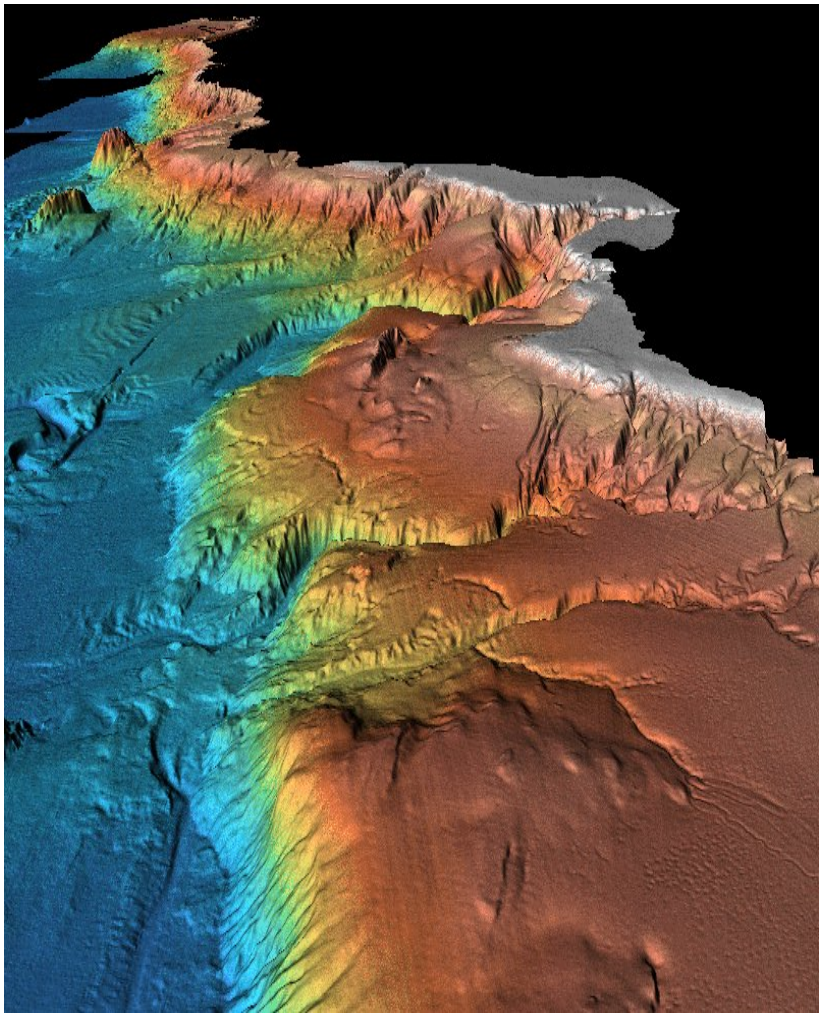
What do most people imagine when they think of marine habitats?

The

"Big Blue Area"

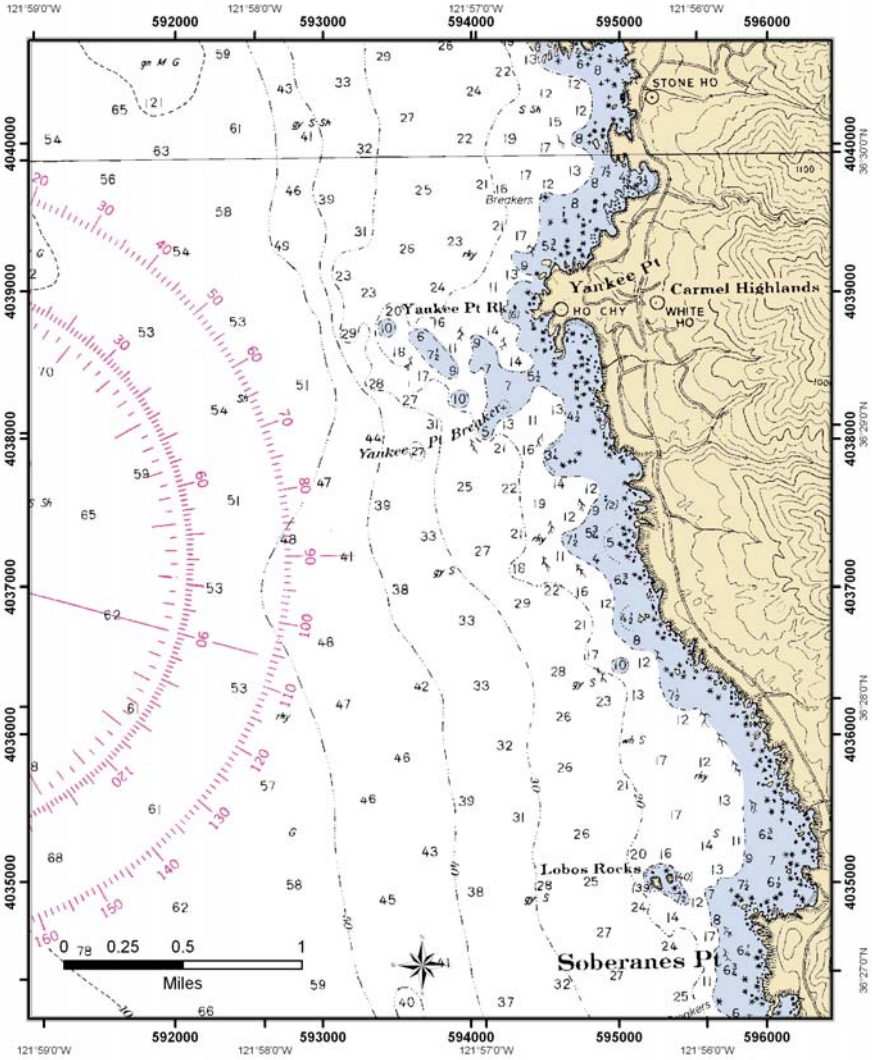
on the map

When in fact:



Marine seafloor habitats are as complex as terrestrial habitats.

NOAA Chart 18686

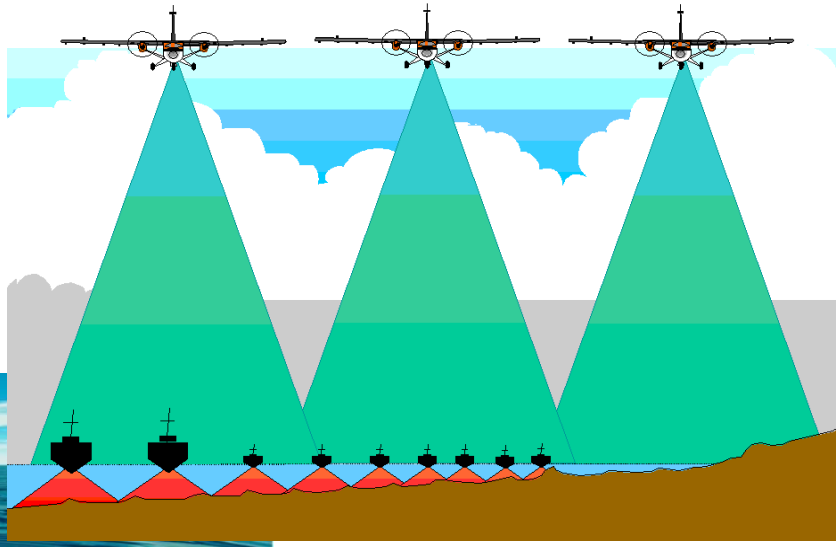


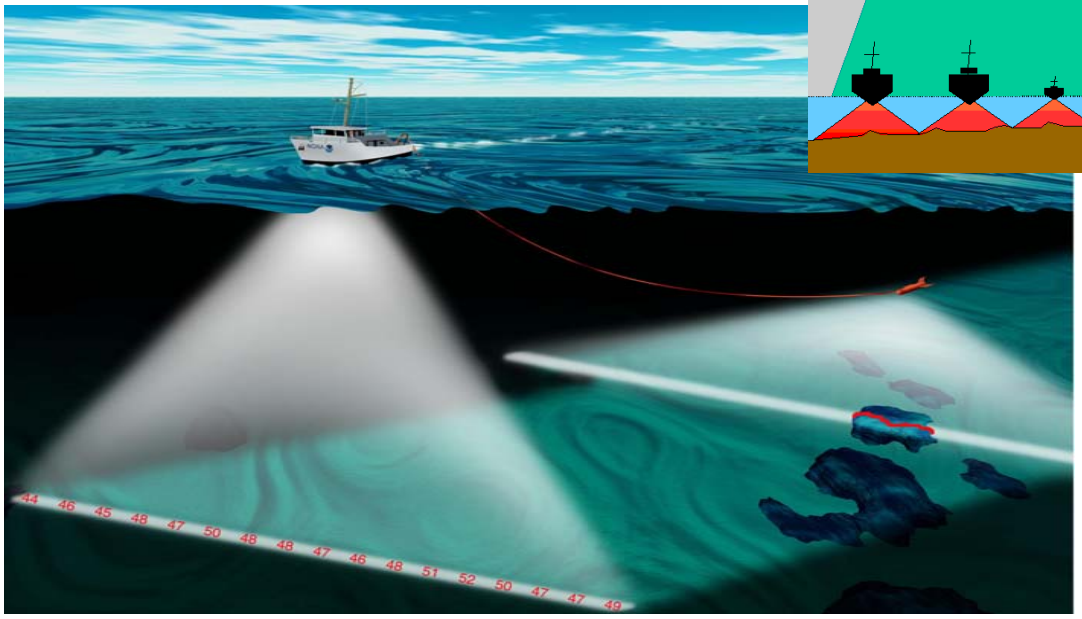
Yankee Point, Big Sur Coast:

Map coordinates: UTM zone 10, WGS 84

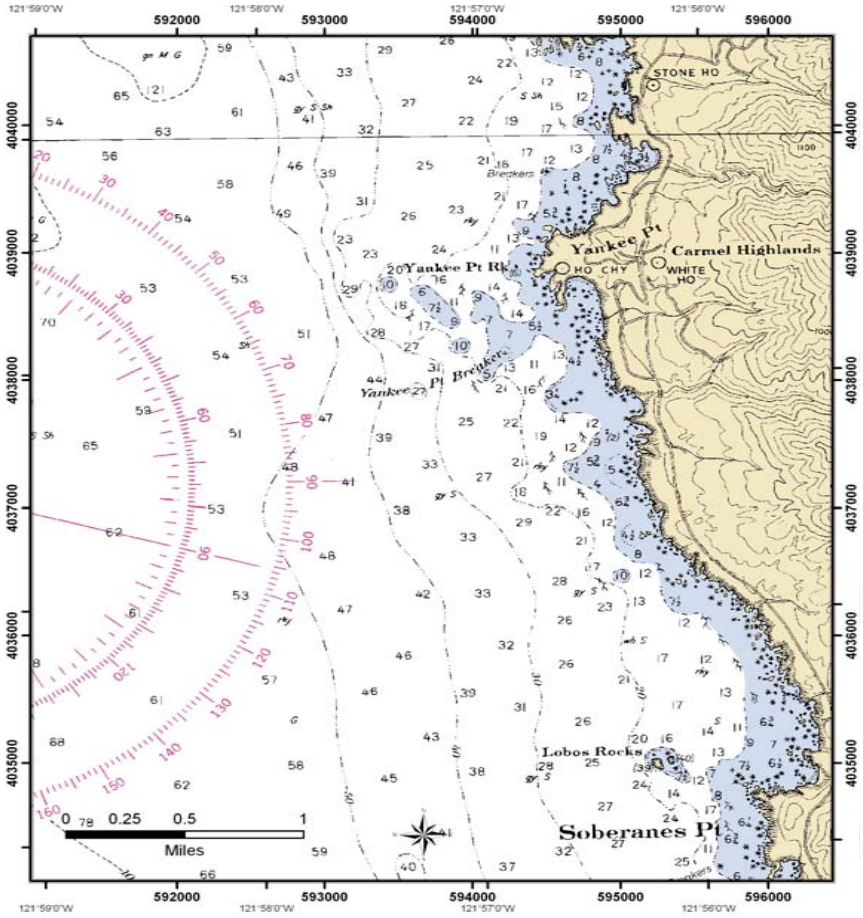
http://seafloor.csumb.edu

Modern Seafloor Mapping Technologies

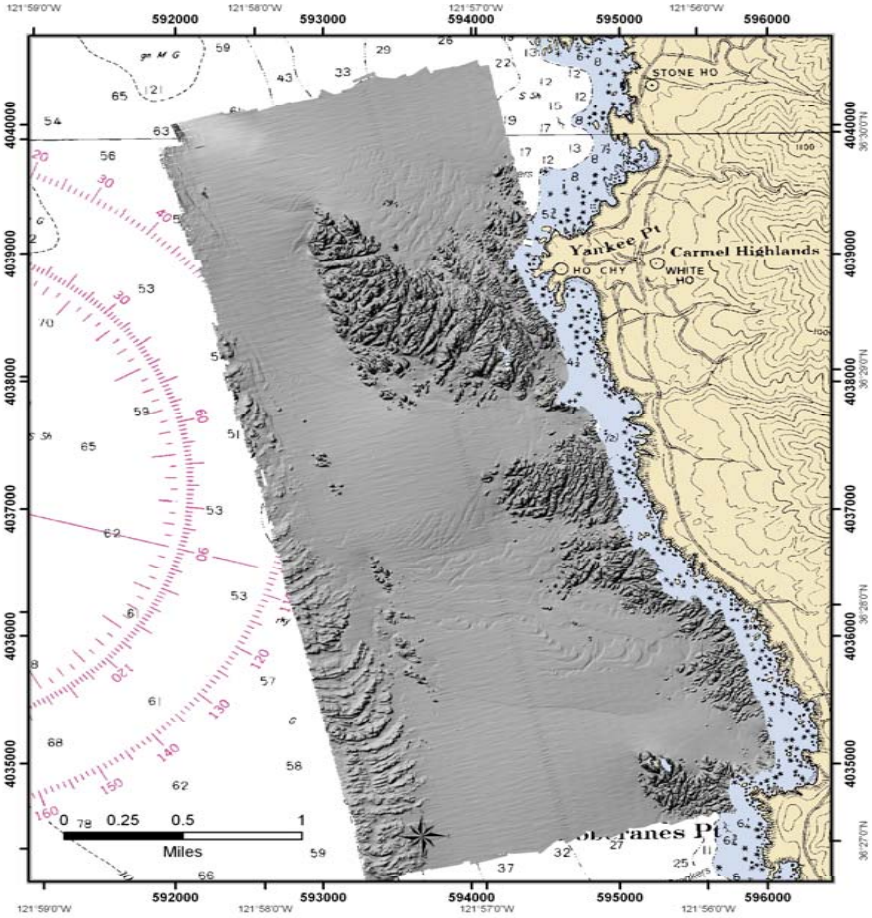




NOAA Chart 18686



Multibeam Bathymetry 3D Shaded Relief Model



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Map coordinates: UTM zone 10, WGS 84

http://seafloor.csumb.edu

Yankee Point, Big Sur Coast:

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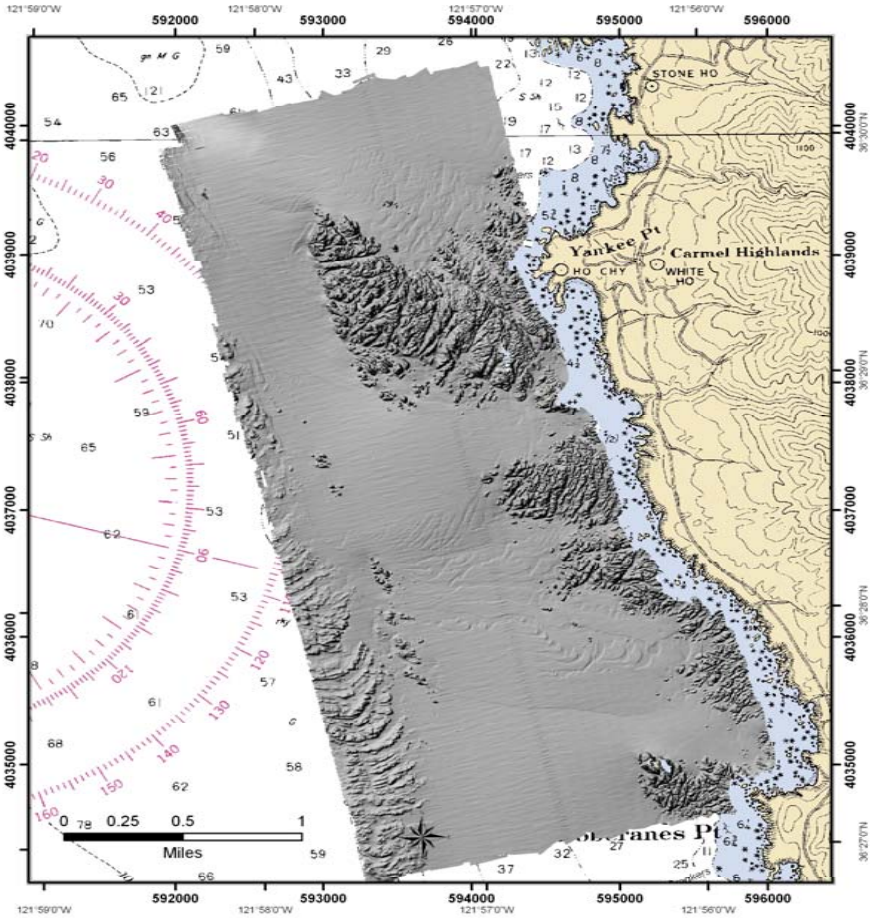
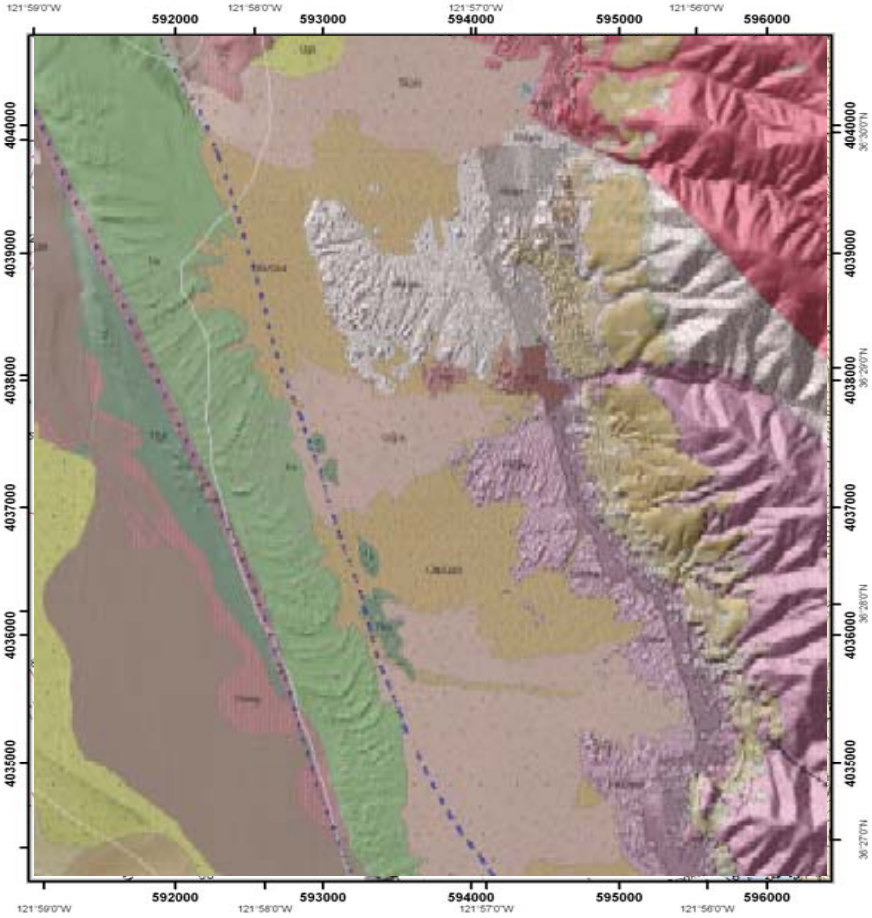
http://seafloor.csumb.edu

Coastal Zone Geology & Habitat Maps

Spanning the Land-Sea interface

Multibeam Bathymetry 3D Shaded Relief Model





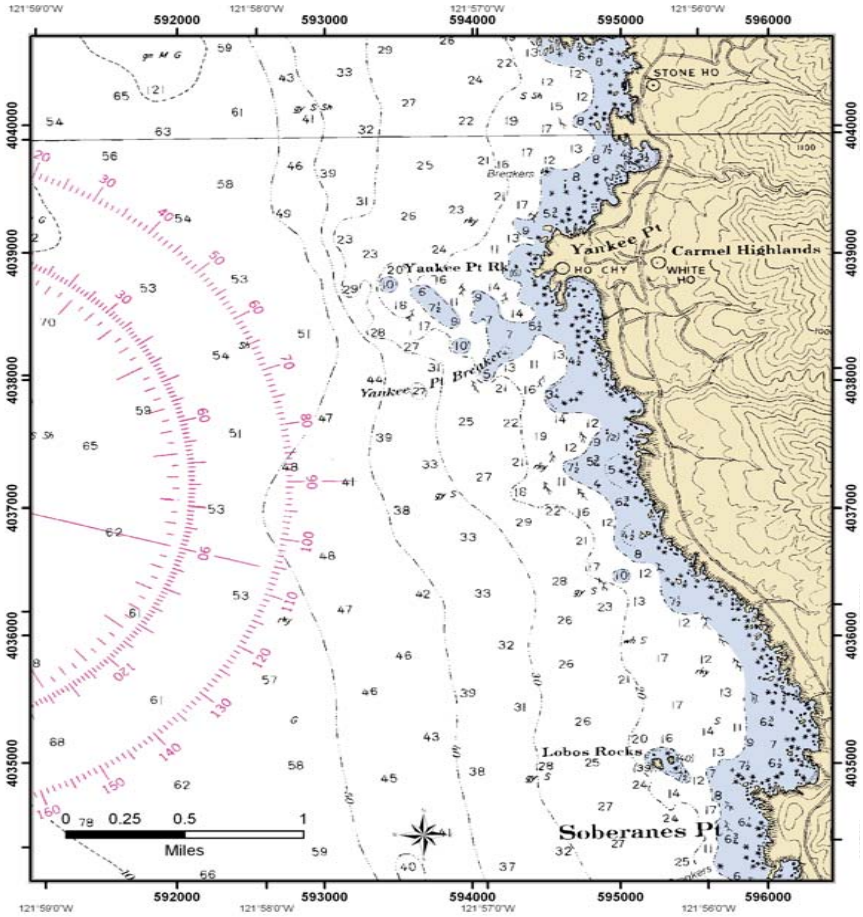
Yankee Point, Big Sur Coast:

Map coordinates: UTM zone 10, WGS 84

http://seafloor.csumb.edu

In 2005 for > 66% of California state waters

NOAA Chart 18686



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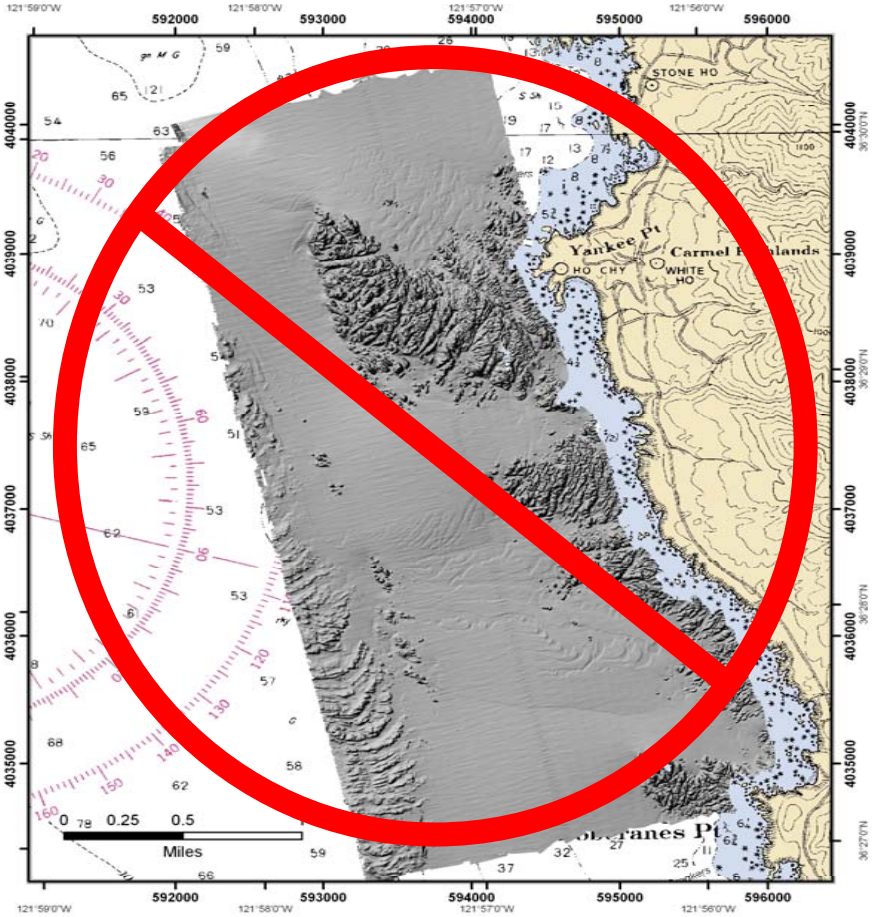

Yankee Point, Big Sur Coast:

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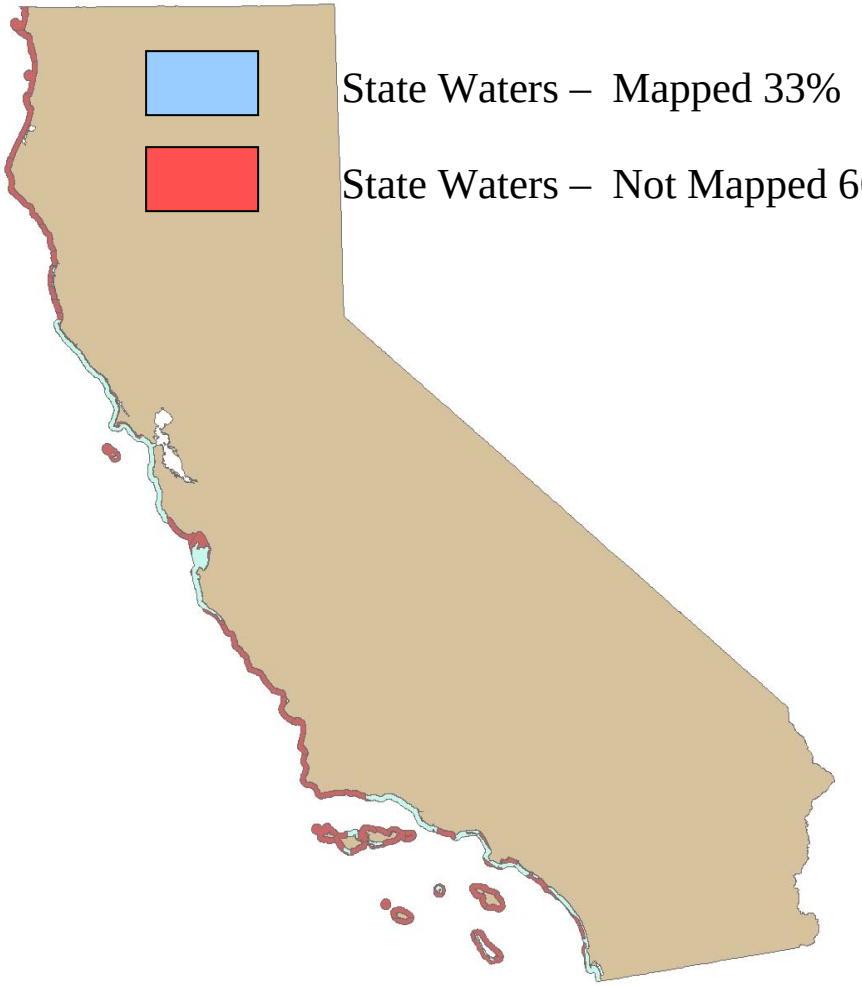
http://seafloor.csumb.edu

California State Waters (MHW – 3 NM)



California Marine Mapping Planning Workshop

December 12 - 13, 2005
California State University, Monterey Bay
Seaside, California
(http://seafloor.csumb.edu/StrategicMappingWorkshop.htm)

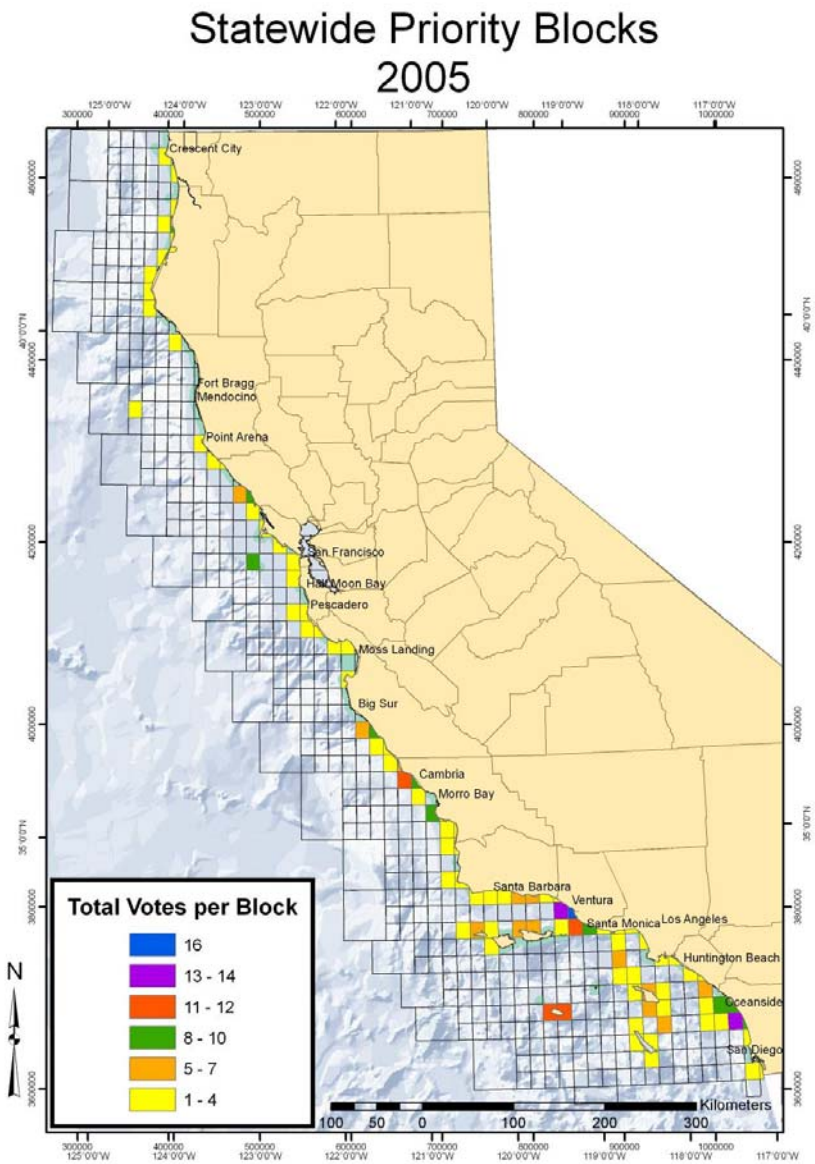
Coastal Conservancy

Statewide Marine Mapping Planning Workshop

The specific objectives for the workshop were to:

- Identify data holdings and data gaps.
- Create a prioritized list of areas for future mapping within state waters.
- Recommend minimum standards appropriate for a comprehensive state waters mapping project.

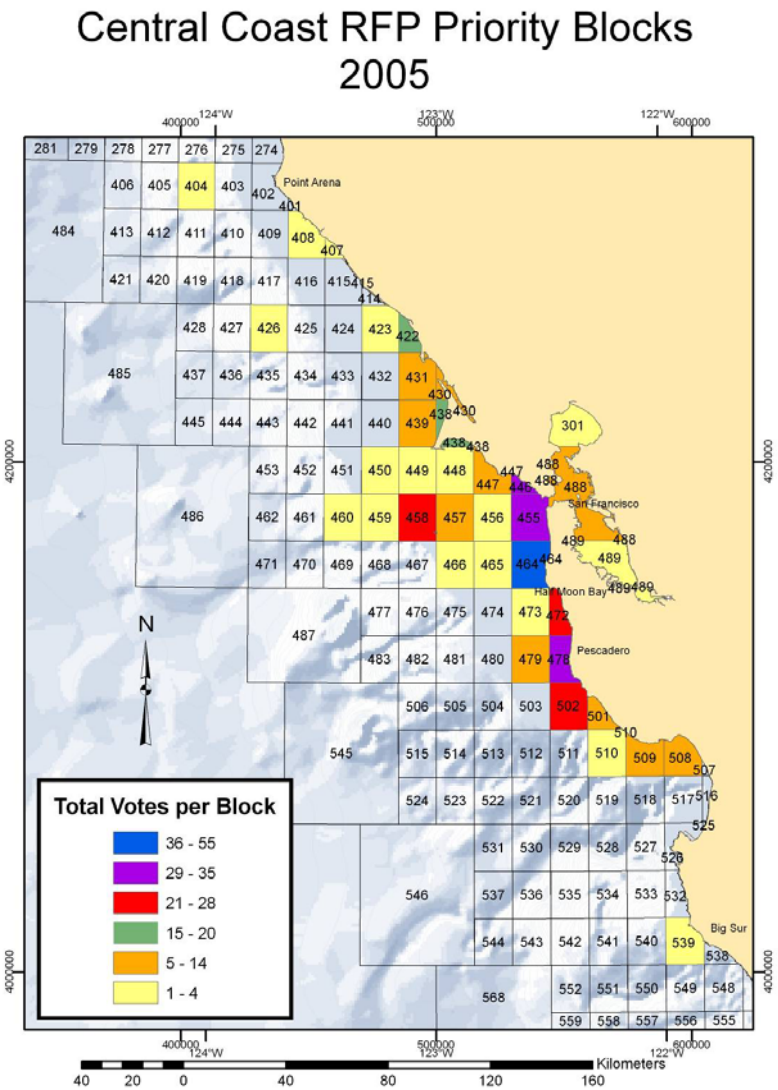
Marine Mapping Planning Workshop



Priority sites for future mapping

Voting results from workshop participants for where future mapping efforts are most needed.

Marine Mapping Planning Workshop

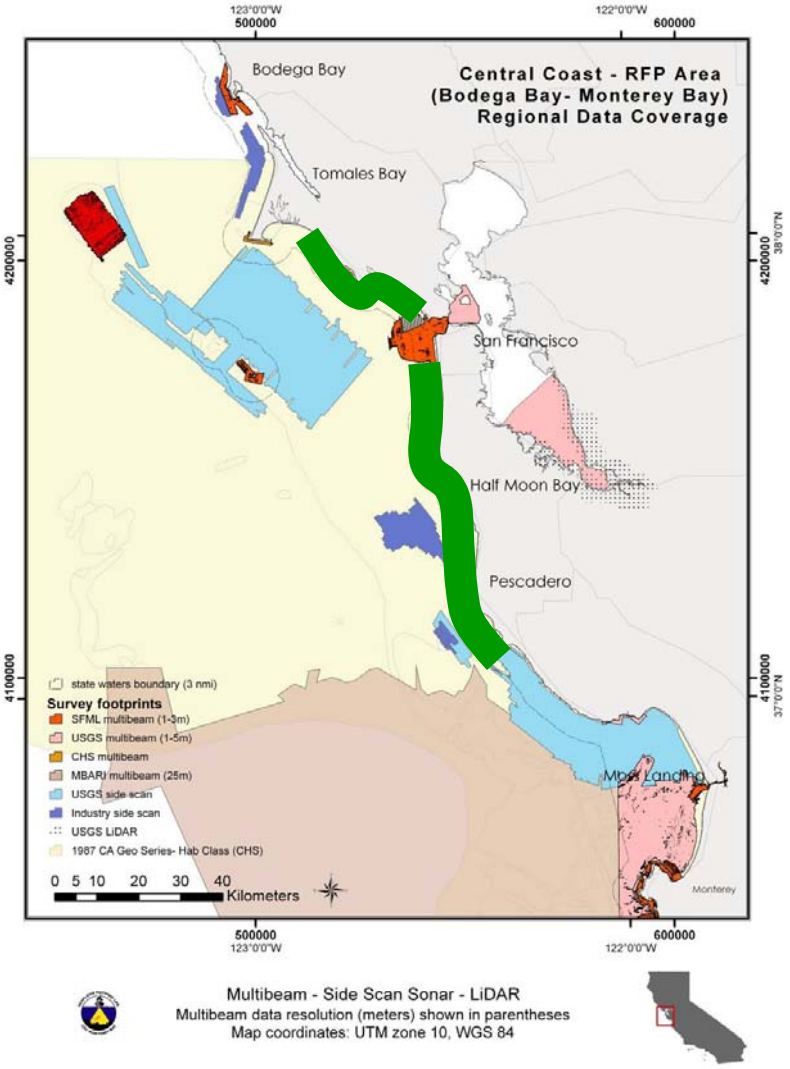


Priority sites for future mapping along Central Coast

Voting results from workshop participants for where future mapping efforts are most needed along central California coast.

Central Coast State Waters Mapping Project 2006-2008

Coastal Conservancy



Monterey Bay
National Marine Sanctuary

North Central Coast Mapping Project (NCCMP)

Supported by

California Ocean Protection Council

California Coastal Conservancy

California Department of Fish and Game

Marine Life Protection Act Initiative

National Marine Sanctuaries Program

NCCMP – Collaborative Project

Partnering Institutions & PI's

Bathymetry Data Collection, Processing & Analysis

CSUMB Seafloor Mapping Lab – Rikk Kvitek

Fugro Pelagos Incorporated – Ed Saade

Groundtruthing, Sub-bottom Profiling & Interpretation

US Geological Survey – Guy Cochrane

Habitat & Geologic Interpretation

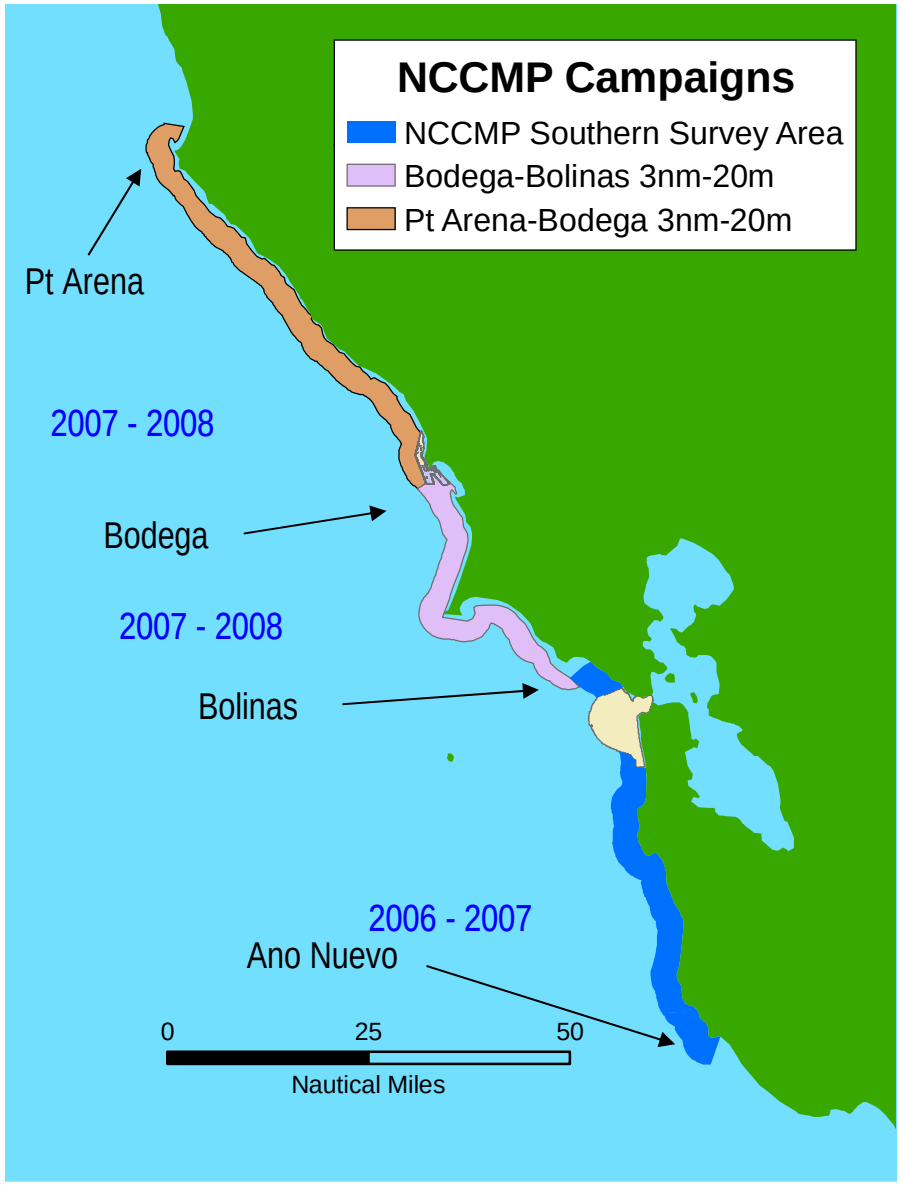
Center for Habitat Studies, Moss Landing Marine Labs

– Gary Greene

California Geological Survey – Chris Wills

Groundtruthing Supported by

National Marine Sanctuary
R/V Fulmar



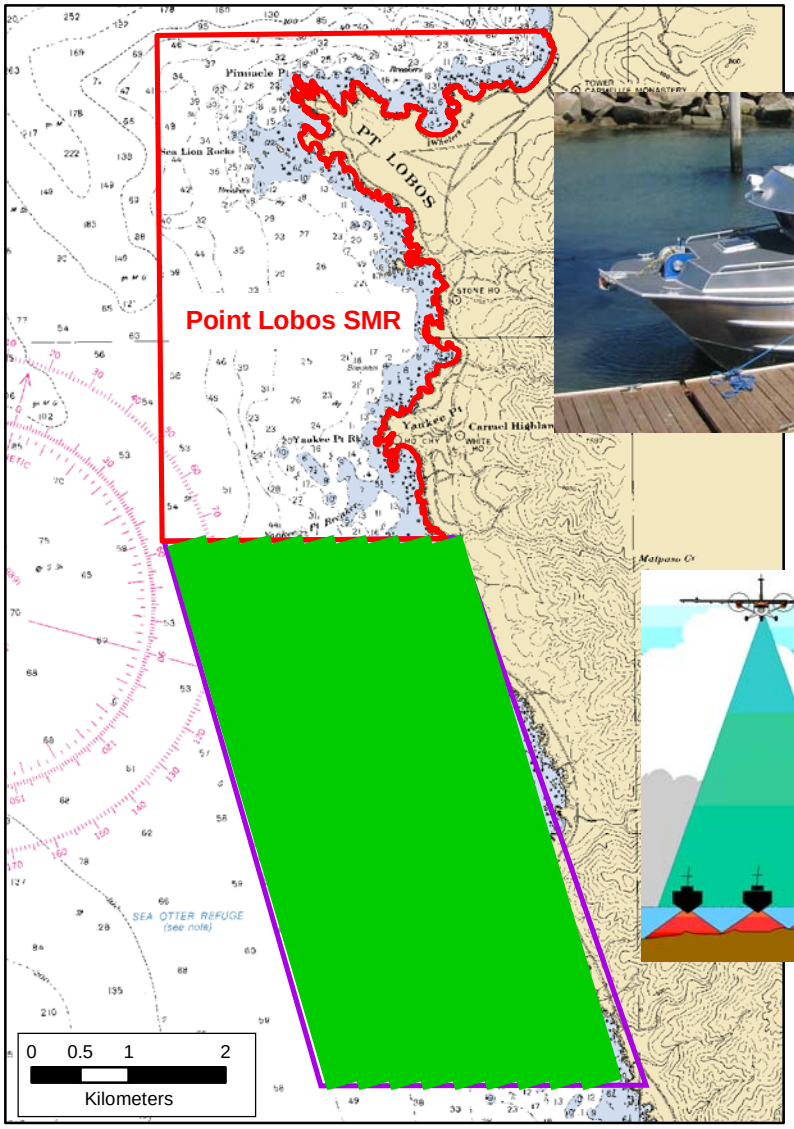
Funded by

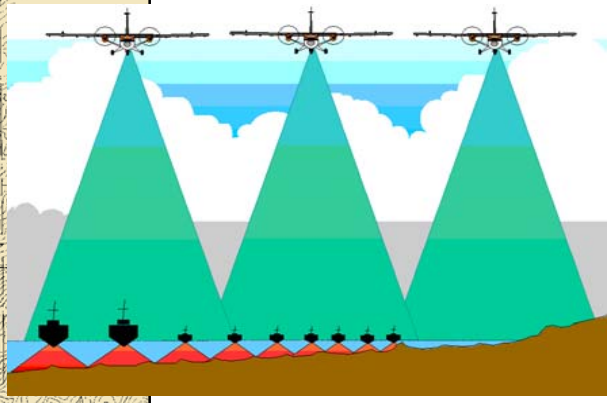
OPC & Coastal Conservancy

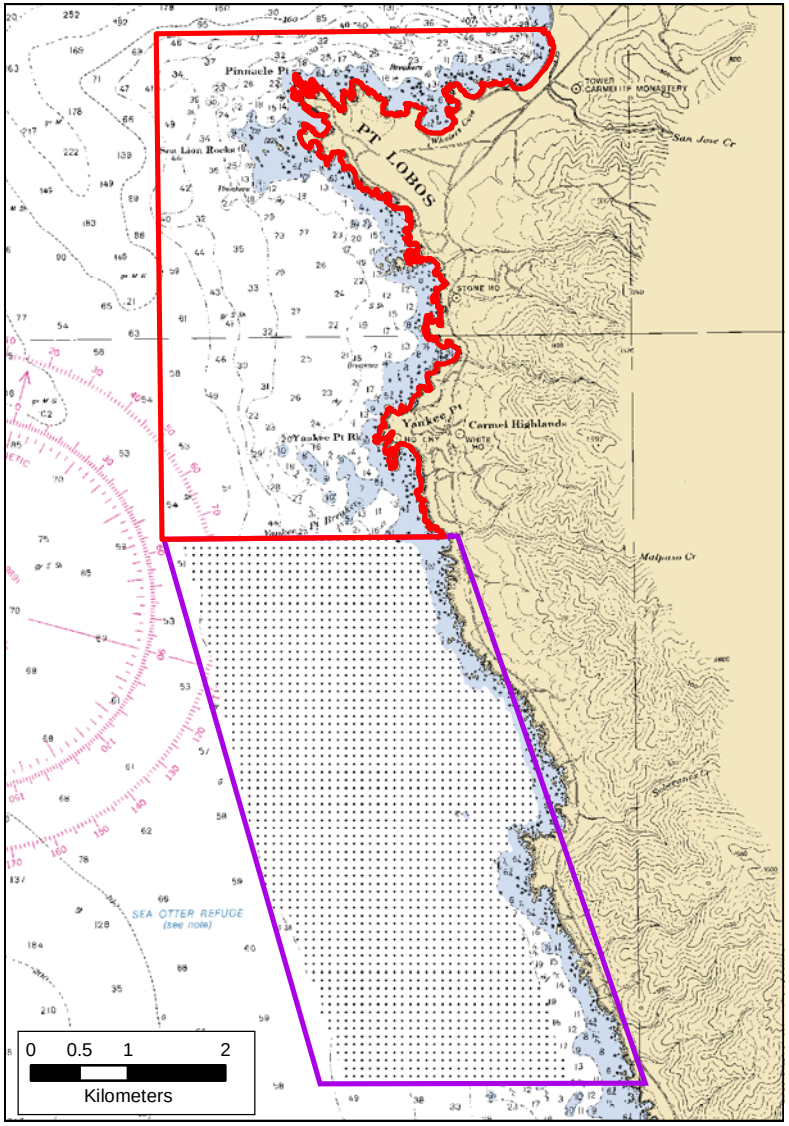
Department Of Fish & Game

OPC & Coastal Conservancy

Data Acquisition - Multibeam Sonar & LIDAR - Mowing the Lawn

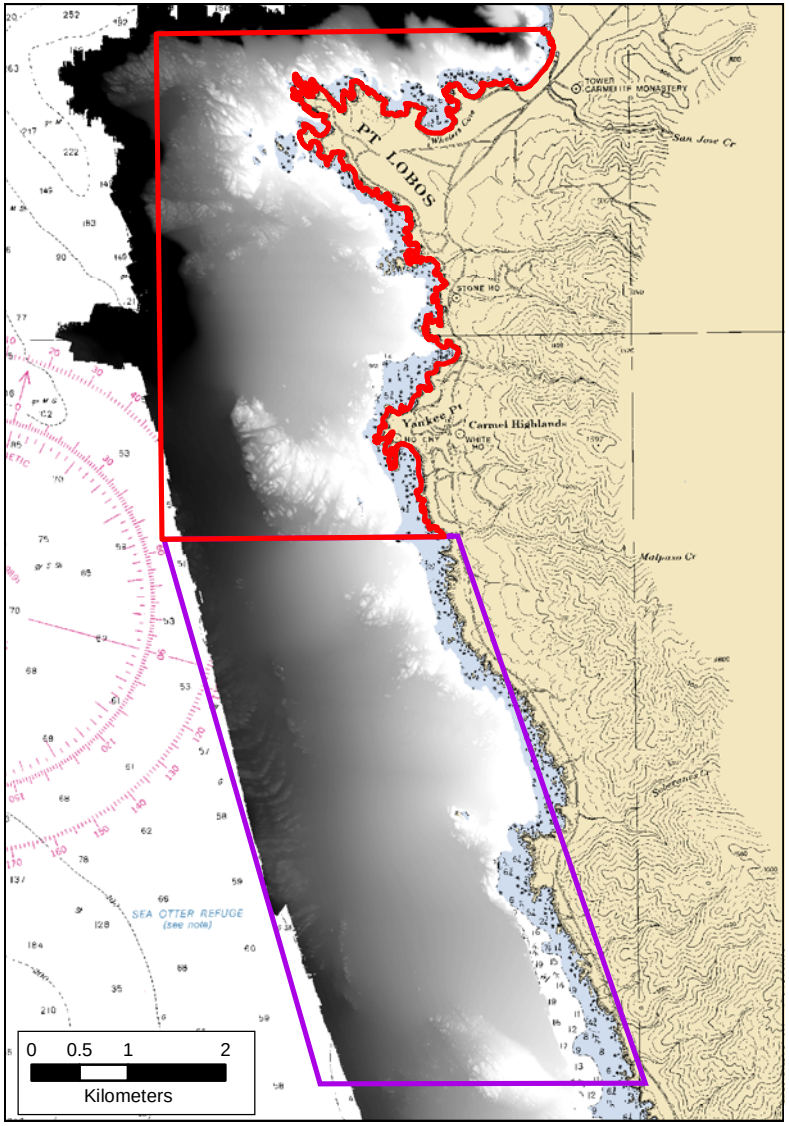






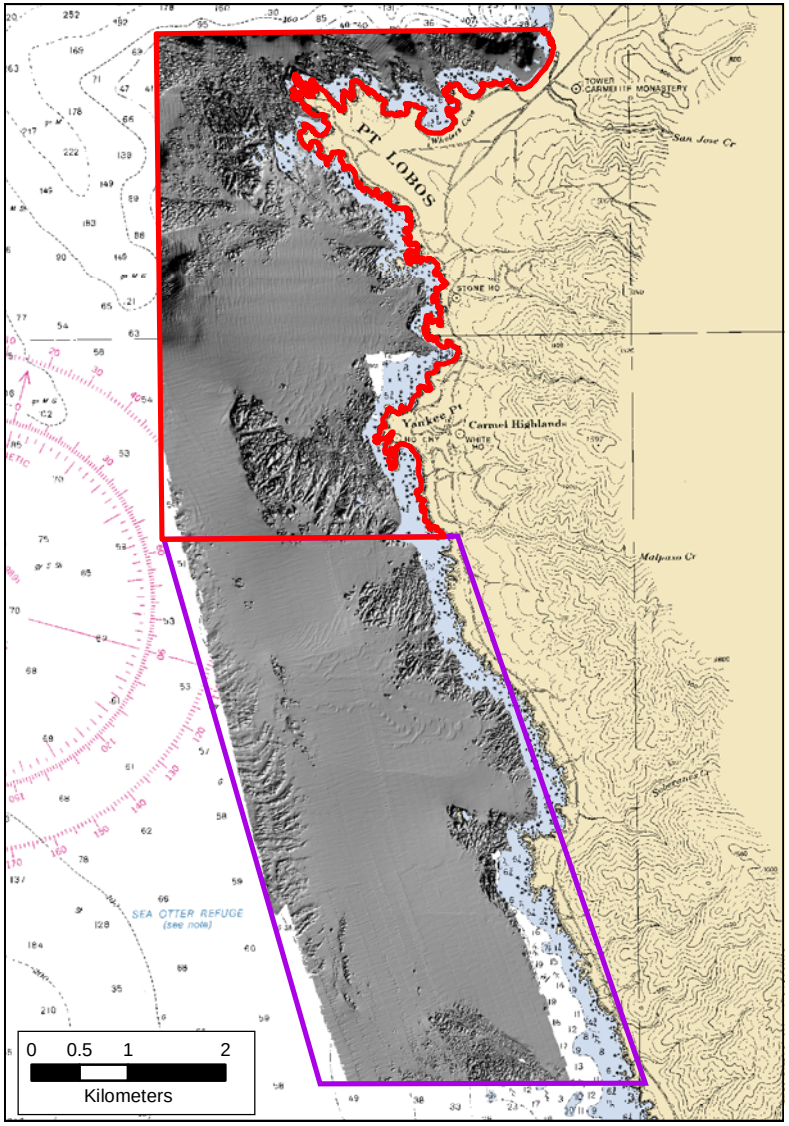
Seafloor Mapping Data - Billions of Depth Soundings

Tier 1 products



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

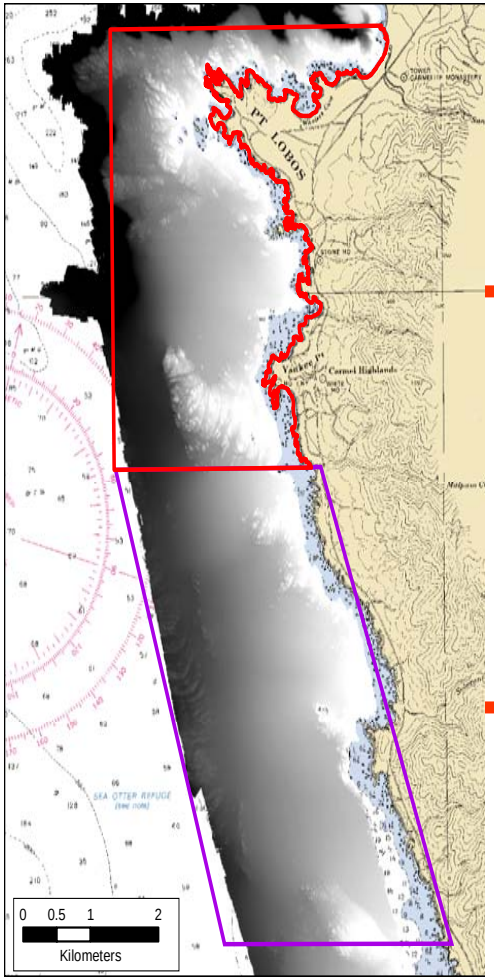
Tier 2 products



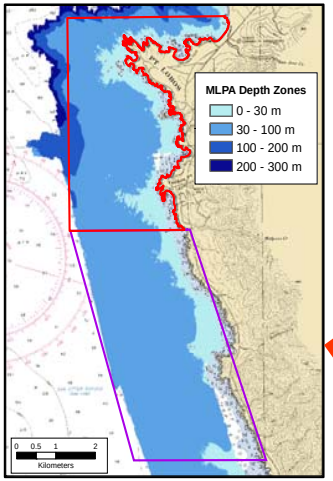
Seafloor Mapping Products - DEM in Shaded Relief

Supervised MLPA Habitat Auto-Classification from DEM

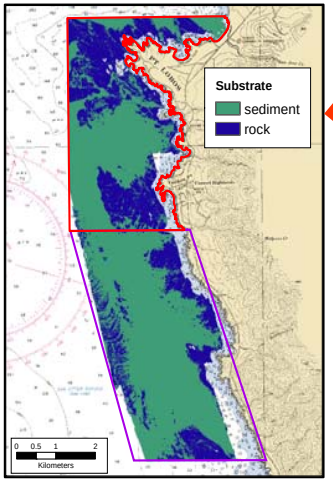
(depth zones + substrate)



Bathymetry Data (DEM)

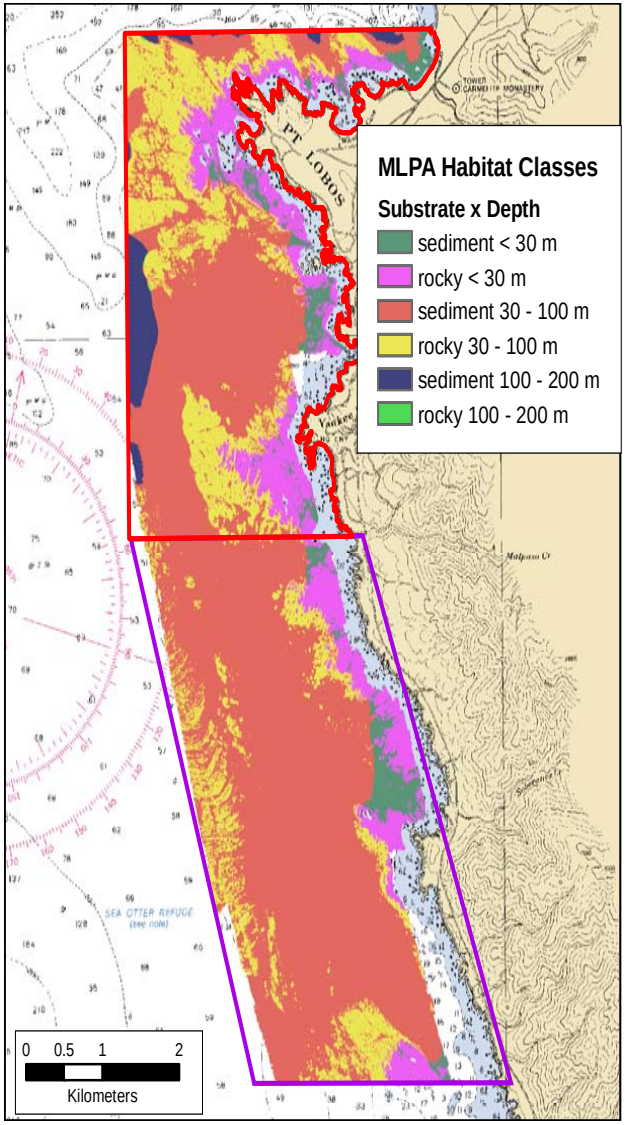


MLPA Depth Zones

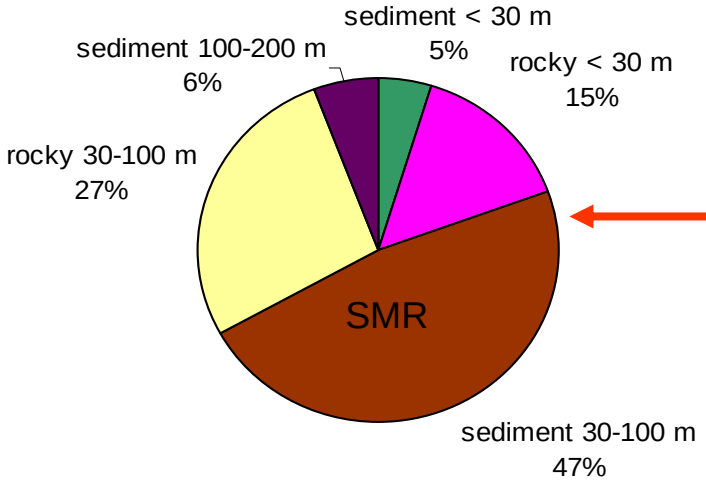


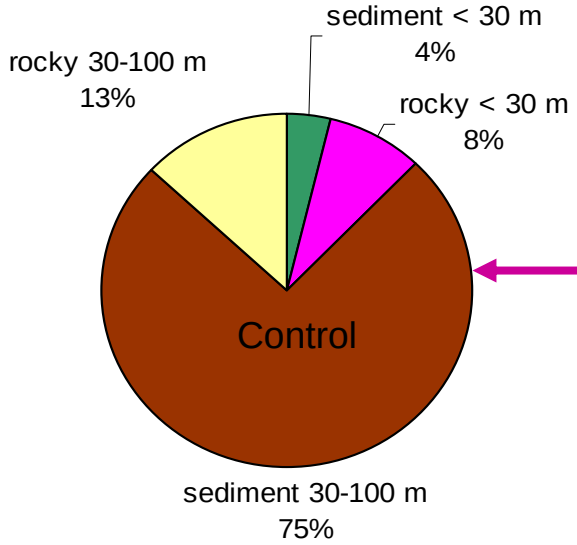
Substrate Map

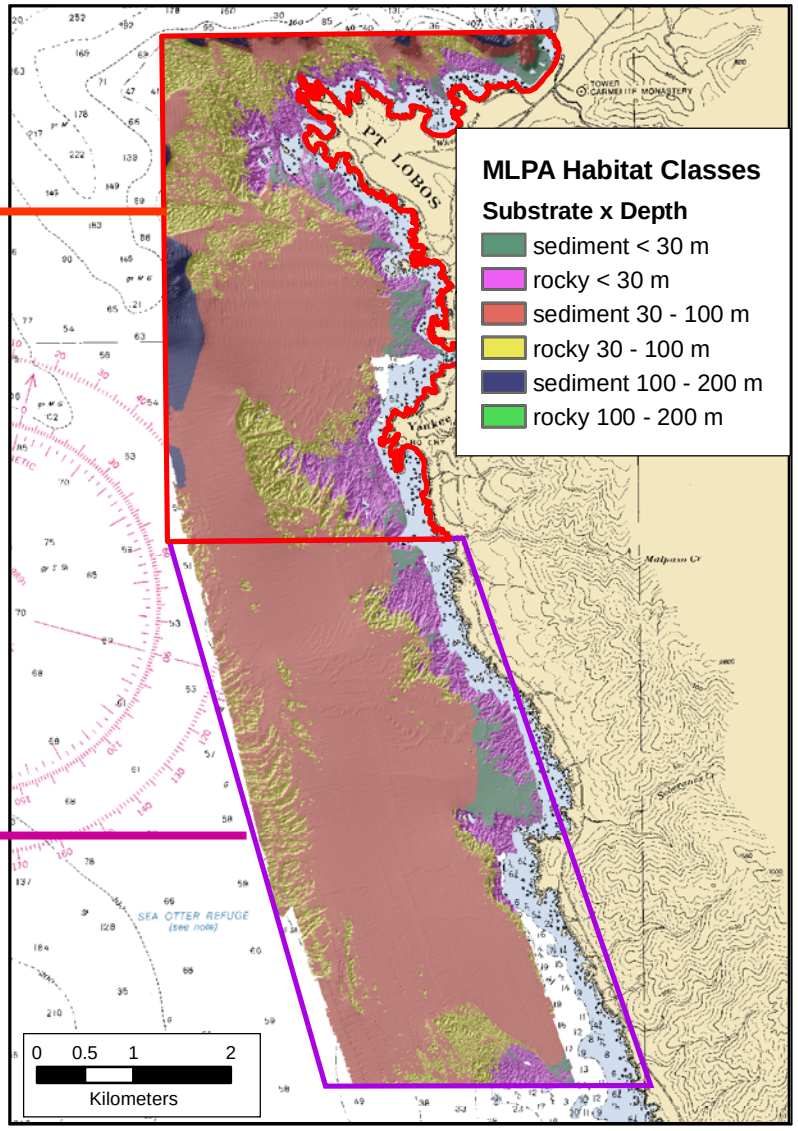
Enhanced Tier 2 products



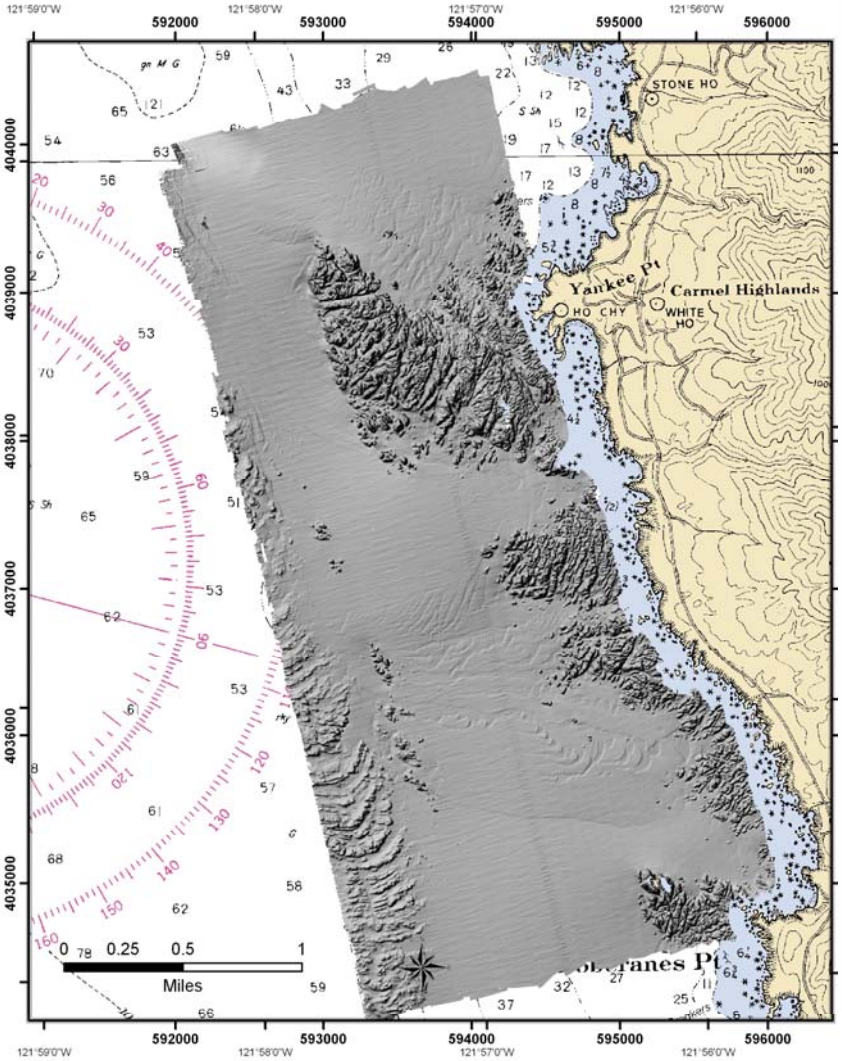
Automated Quantitative Comparison of Habitat Abundance







Multibeam Bathymetry 3D Shaded Relief Model

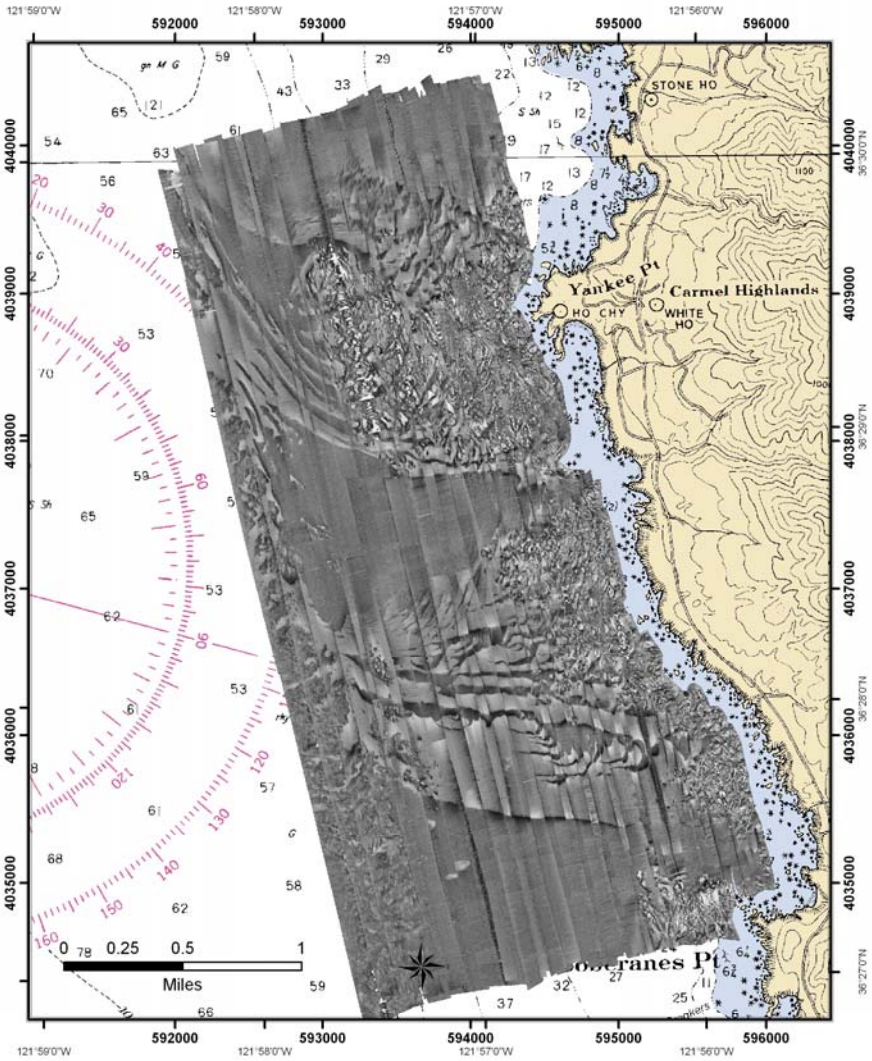


Yankee Point, Big Sur Coast:

Map coordinates: UTM zone 10, WGS 84

http://seafloor.csumb.edu

Sidescan Sonar 2D Backscatter Imagery



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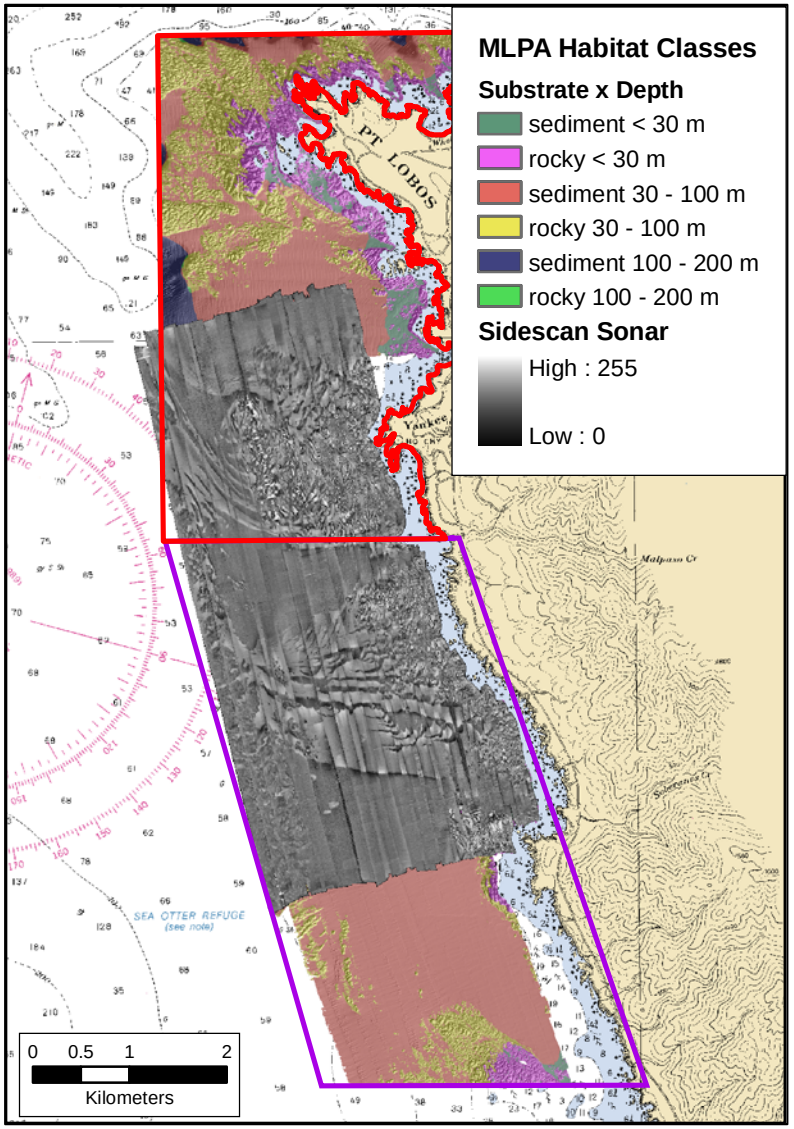
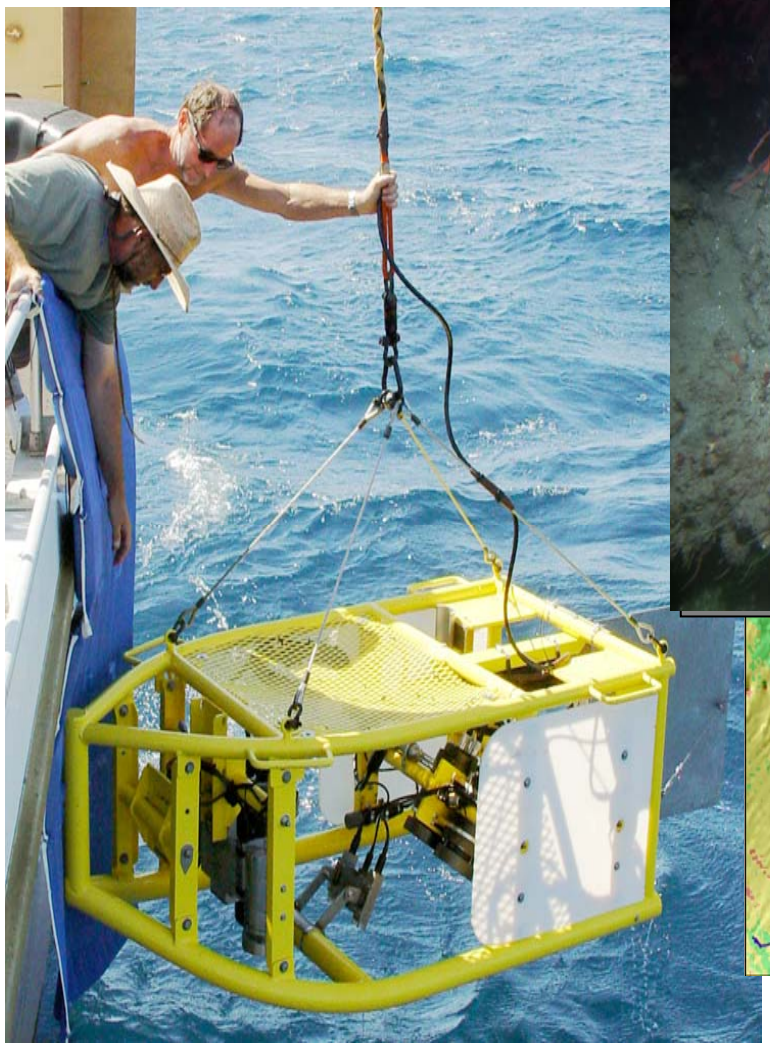
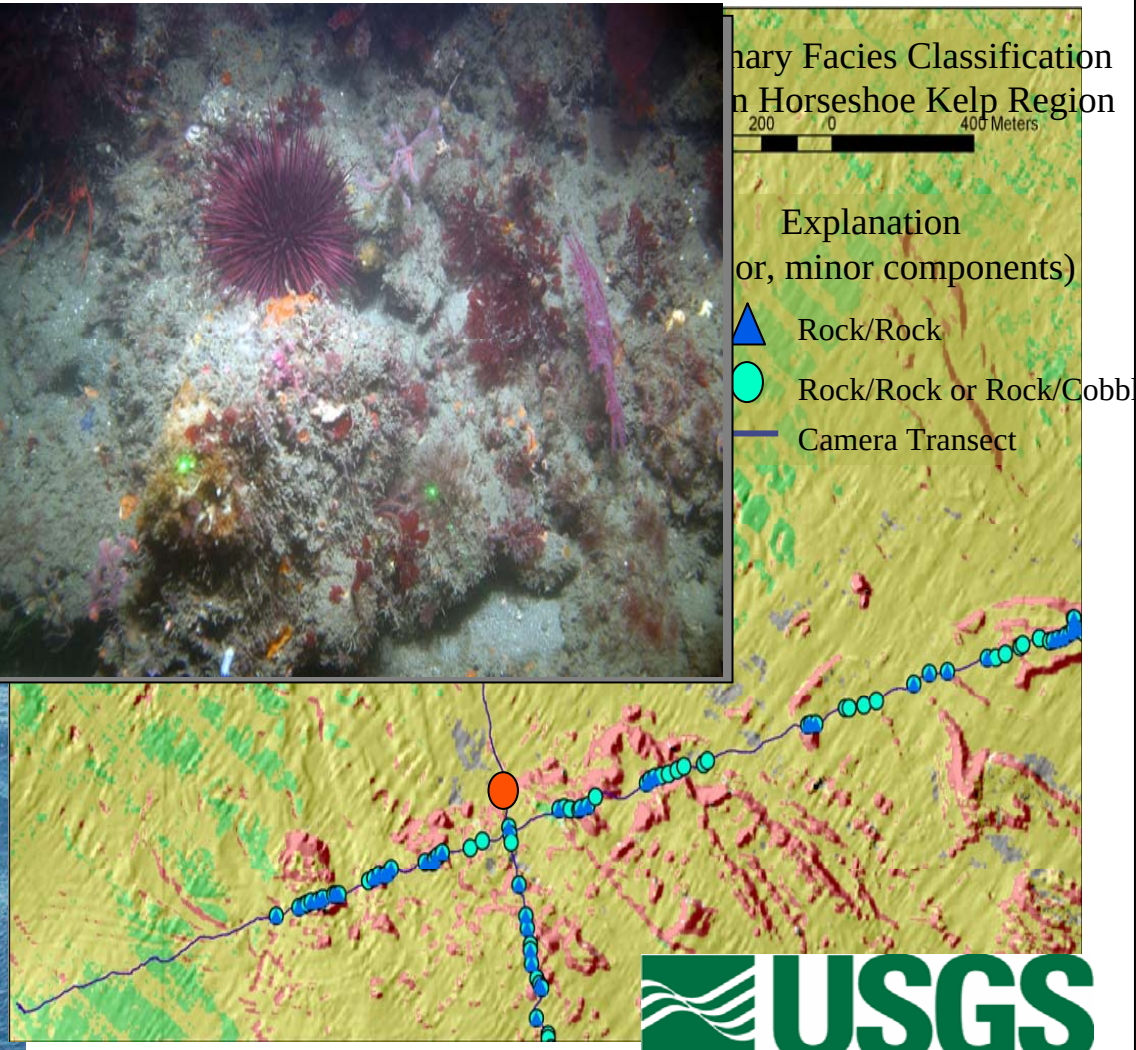


Seafloor Mapping Products - Sediment Classification from Sidescan Sonar Mosaic

Video Groundtruthing

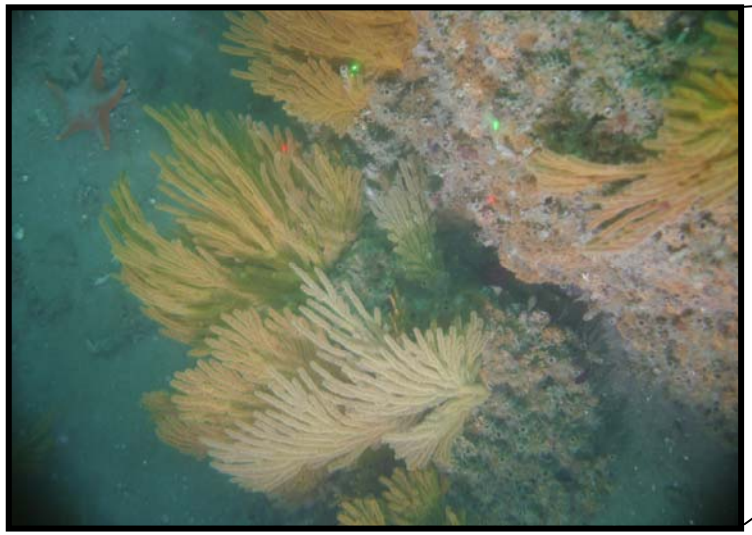
(limited & strategic)



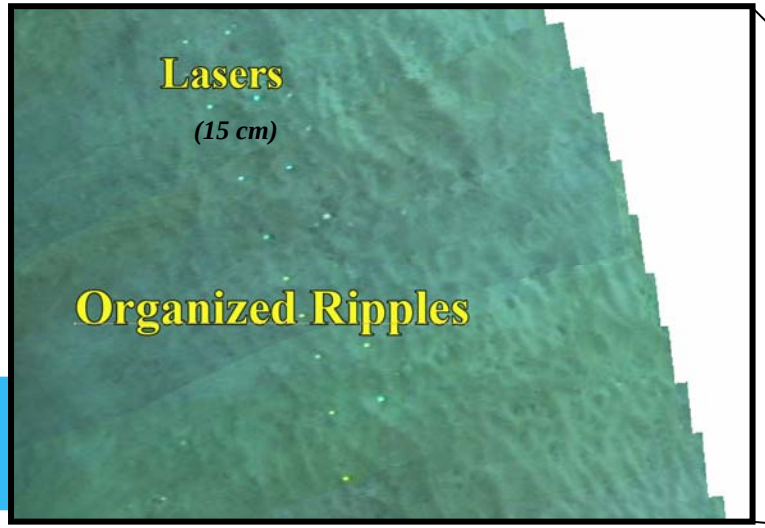


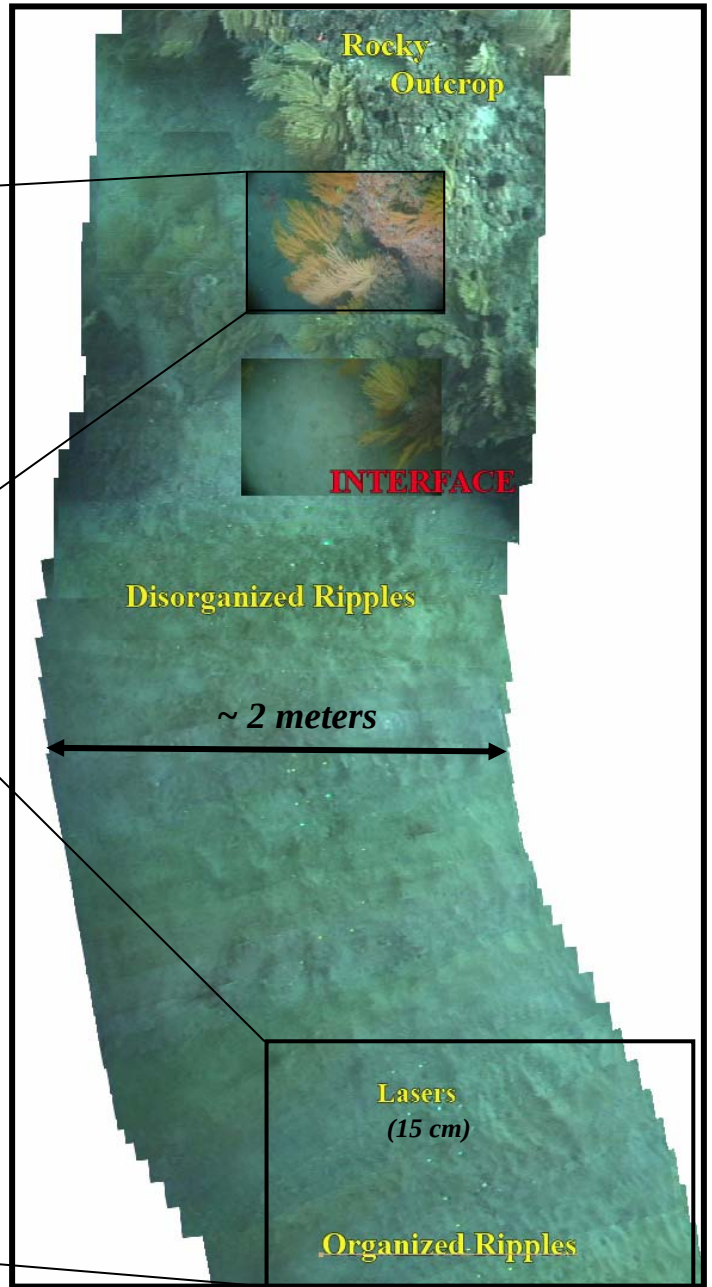
USGS
science for a changing world

Video Mosaic
With
Geo-referenced Still Photographs



6 Mpixel



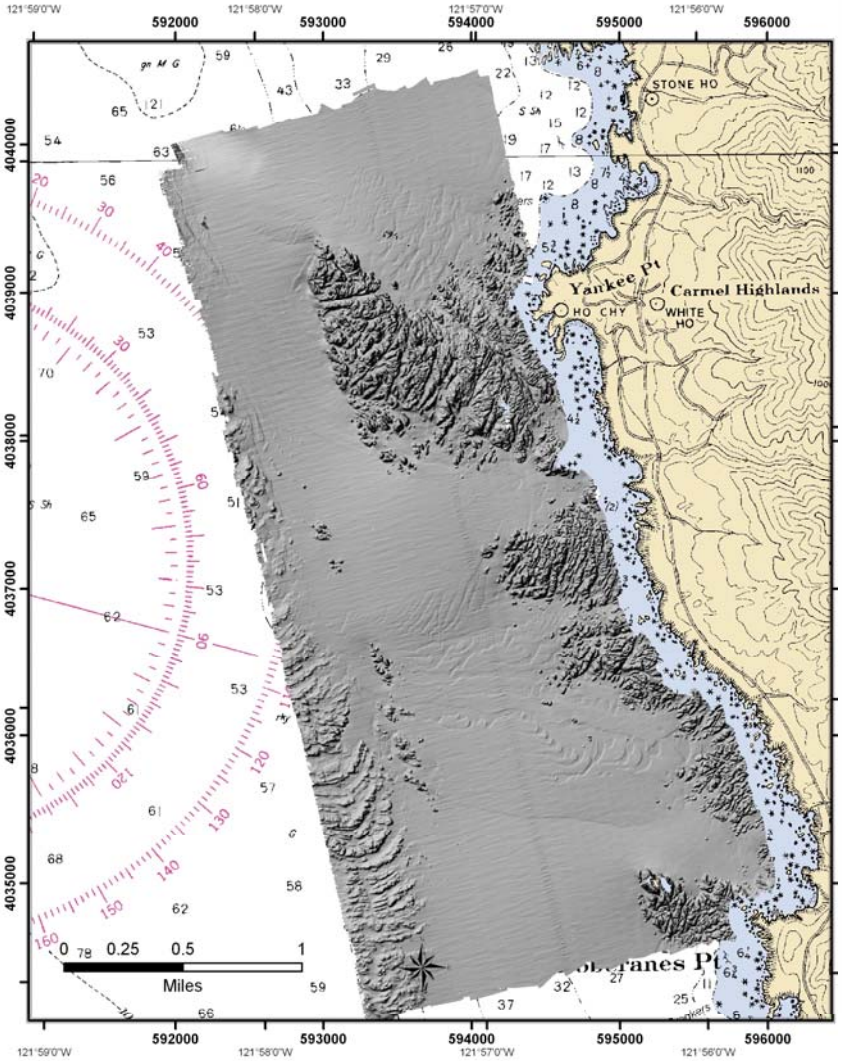


72 dpi

But:

Is surface mapping the seafloor enough?

Multibeam Bathymetry 3D Shaded Relief Model



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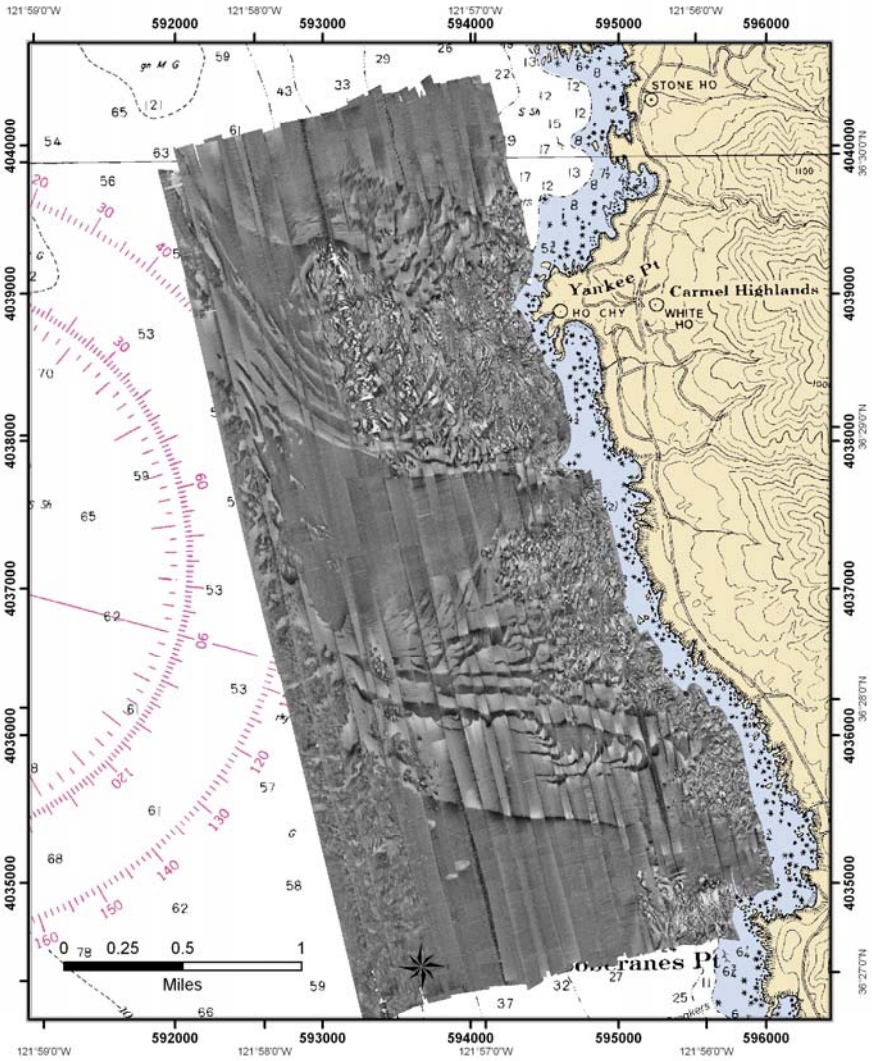
Sidescan Sonar 2D Backscatter Imagery



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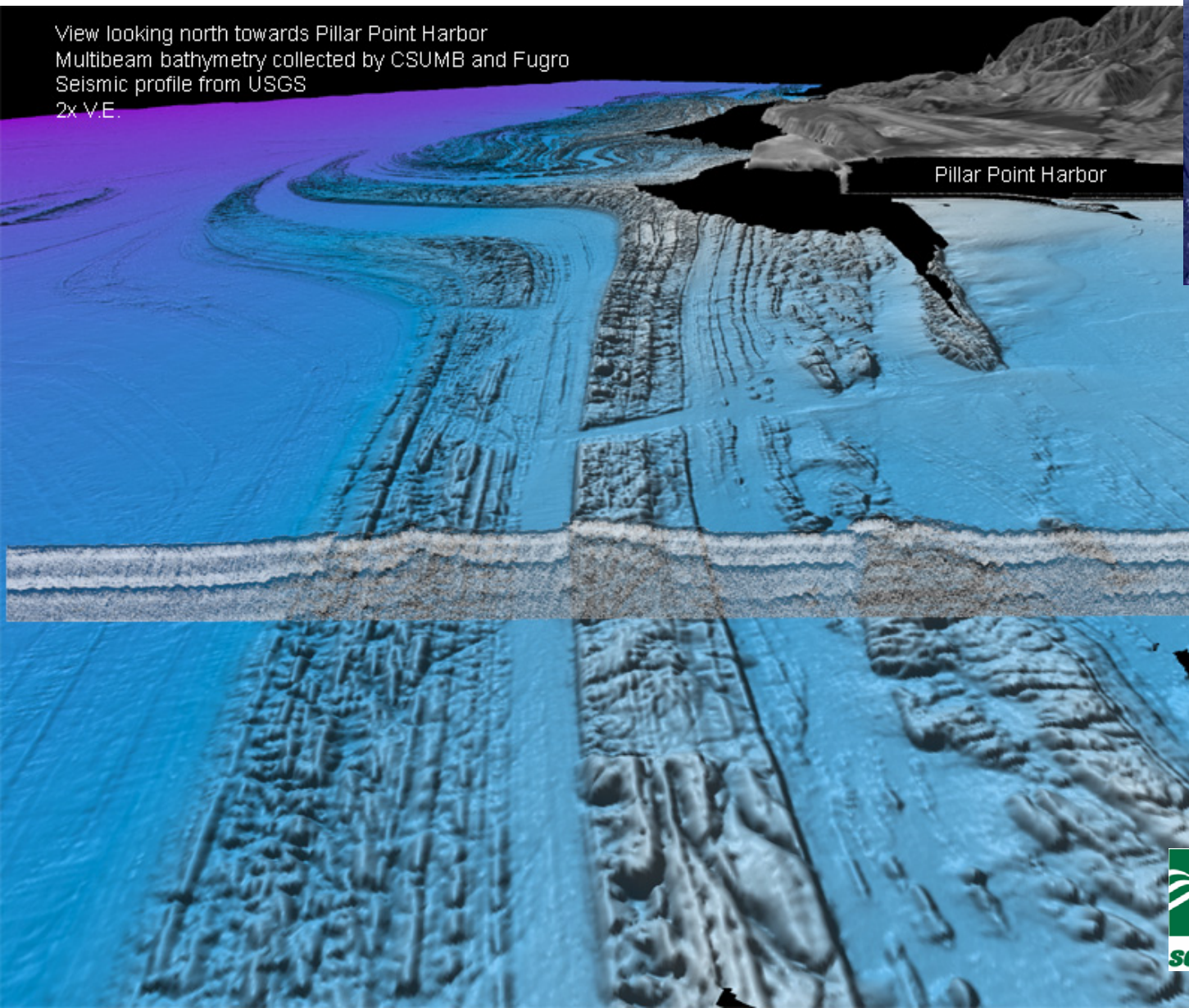
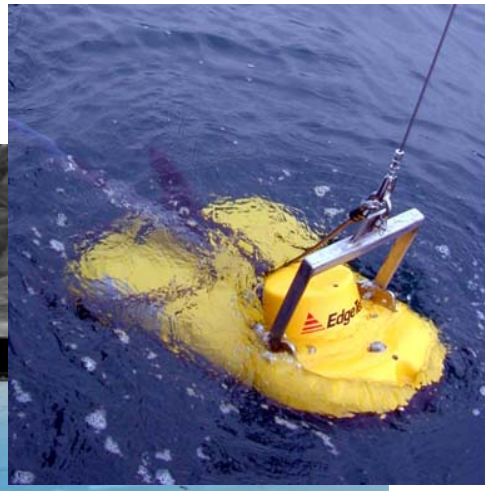
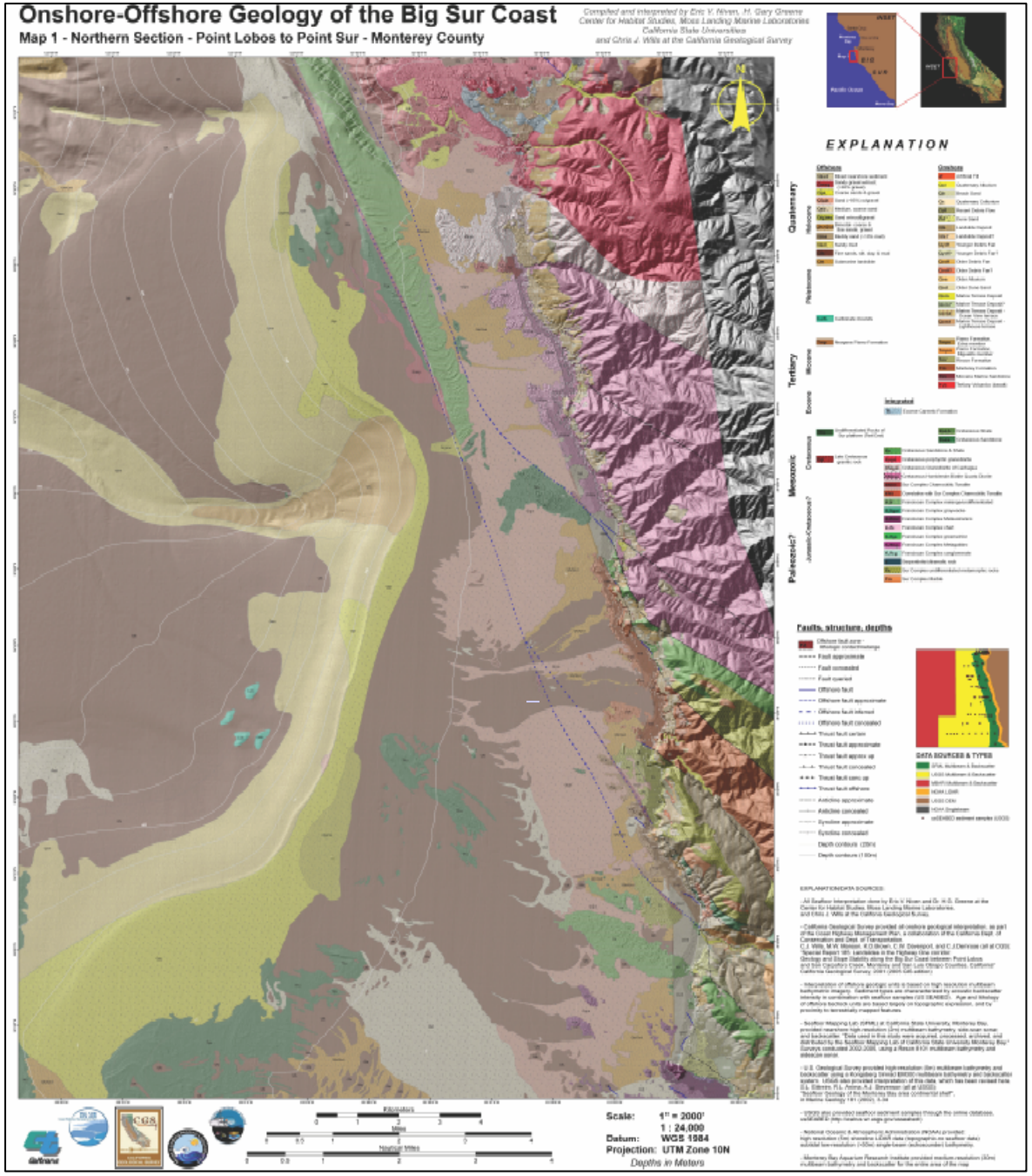
Sub-bottom Profiling

(limited & strategic)





USGS
science for a changing world



Final Tier 3 Products

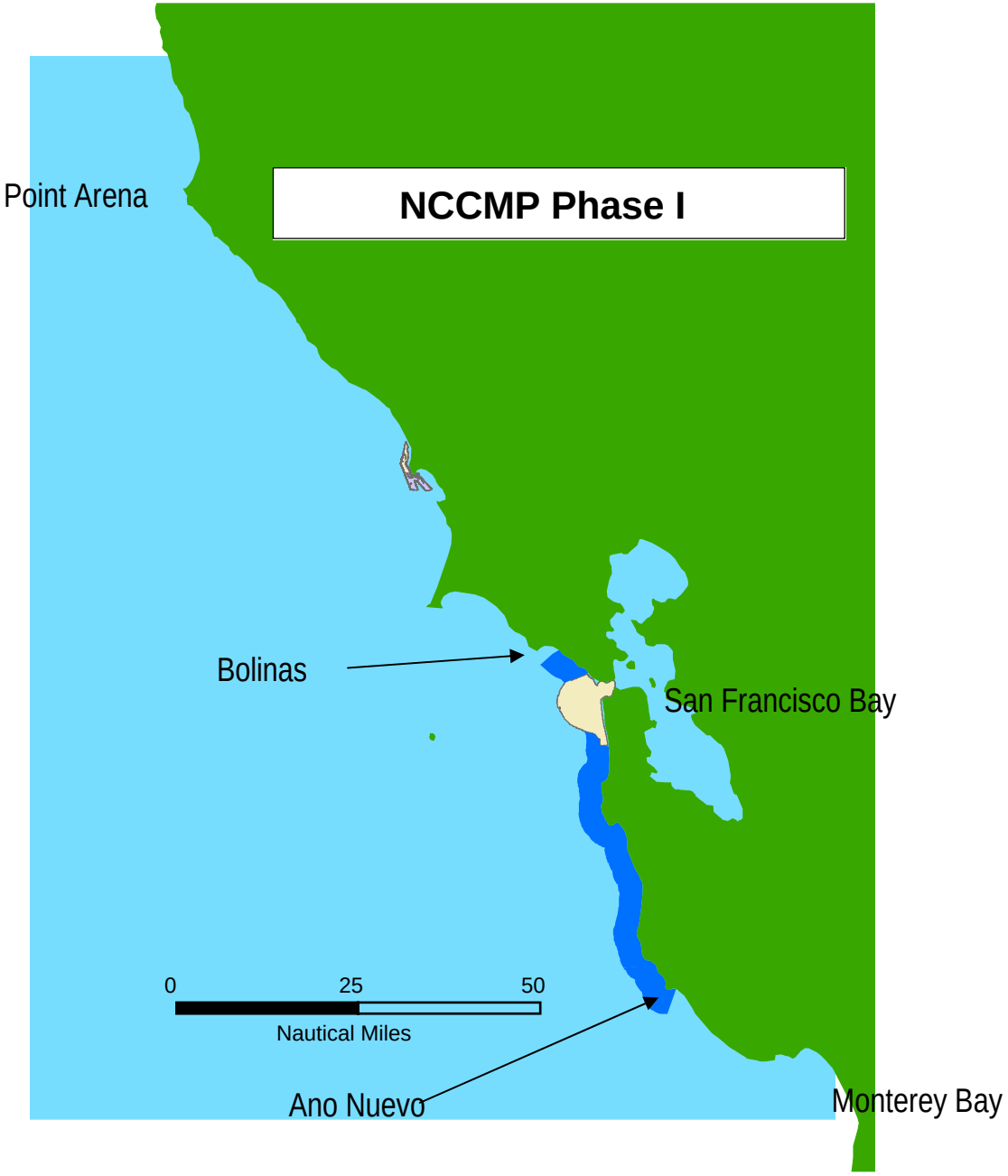
Quad scale 1:24,000 strip charts spanning state waters and coastal zone showing:

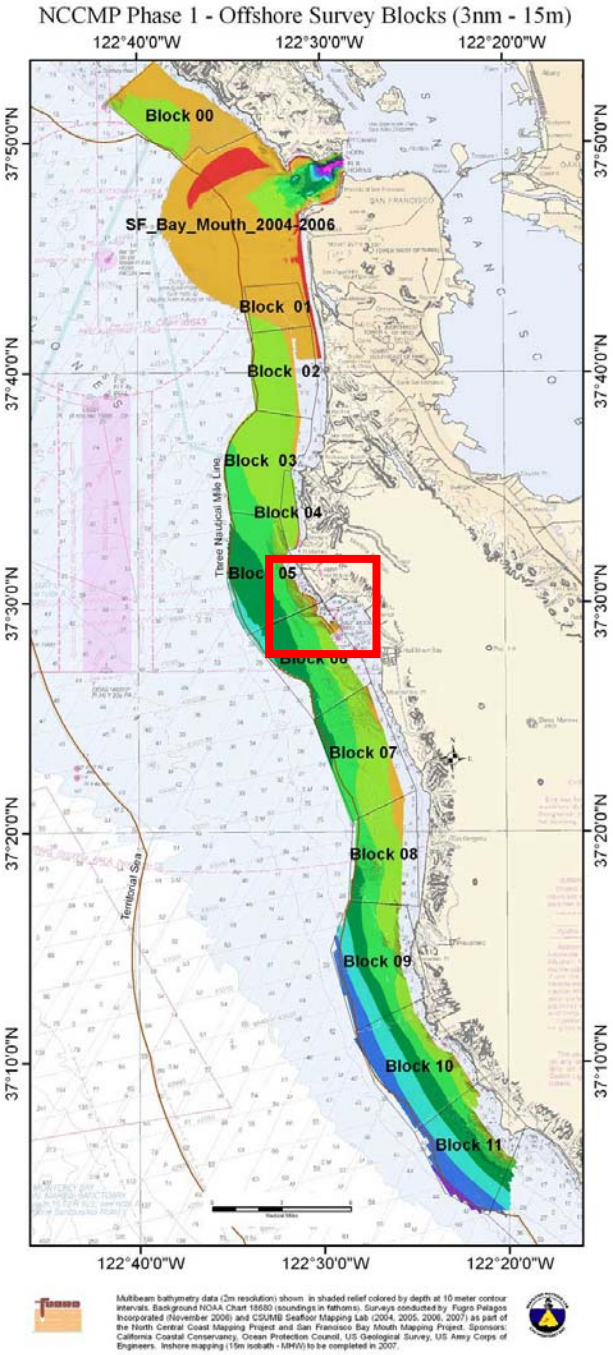
Onshore-Offshore Geology

CGS
CALIFORNIA GEOLOGICAL SURVEY

CENTER FOR HABITAT STUDIES
MOSS LANDING MARINE LABORATORIES

So, how’s the NCCMP going so far?


NCCMP Phase I
Point Arena
Bolinas
San Francisco Bay
0
25
50
Nautical Miles
Ano Nuevo
Monterey Bay



NCCMP Phase I

Vessel-supported

Acoustic surveys

Offshore (3nm – 15m isobath)

24 hr ops

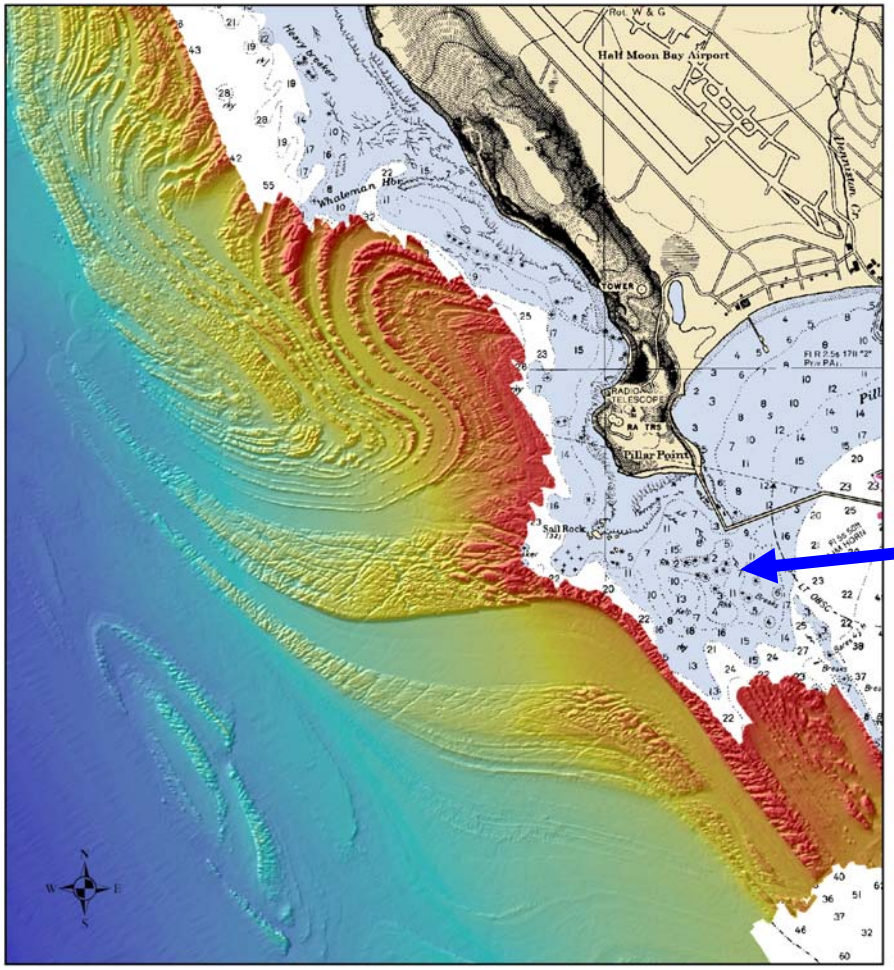
Completed spring 2007

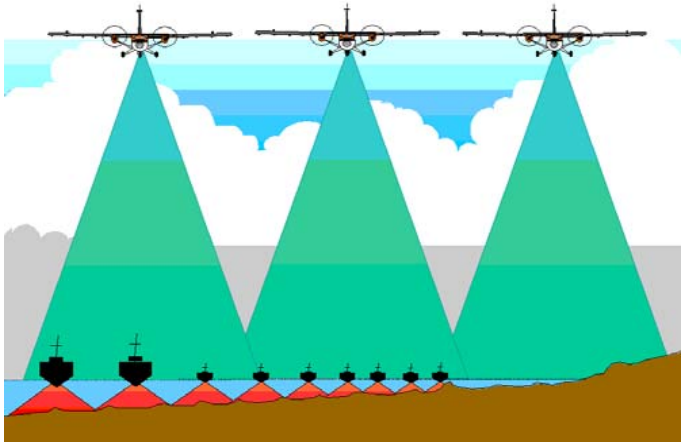
Nearshore (15 – 5 m isobath)

Daylight ops

Completed summer 2007

Mavericks - Half Moon Bay, California





LIDAR was a “bust” in areas too hazardous for safe vessel navigation.

MHW – 5 m isobath

Water clarity & surface conditions prevented sufficient penetration.

0 500 1,000
Meters

Multibeam bathymetry data (2m resolution)

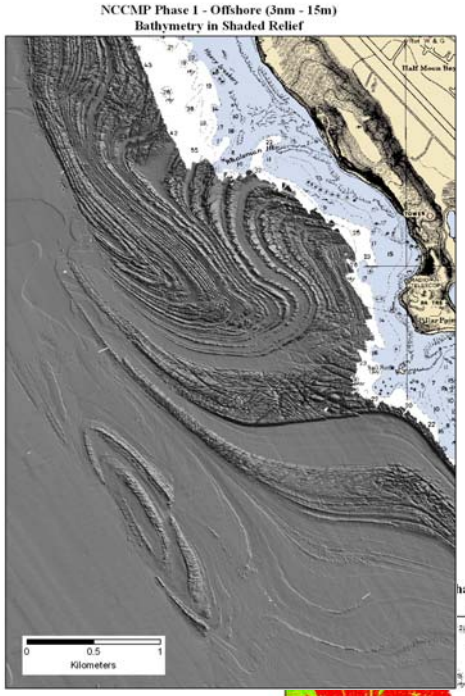
NCCMP Phase I Offshore

3nm – 15m isobath

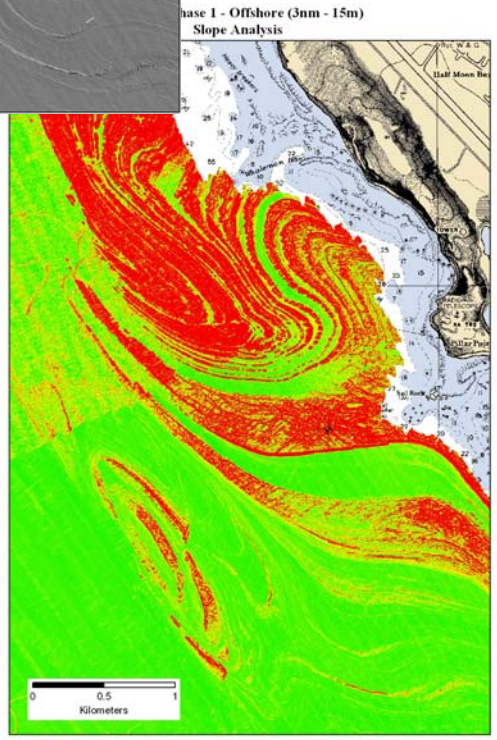
Tier 1 & 2 Products

Completed July 2007

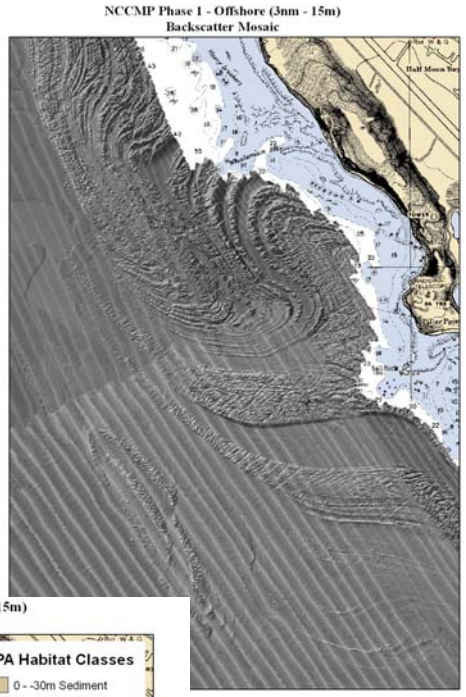
(400 files & 200 GB)



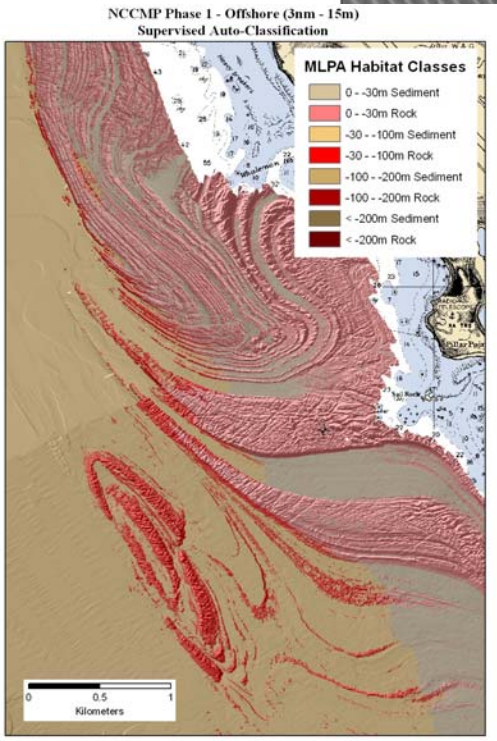
DEM grids



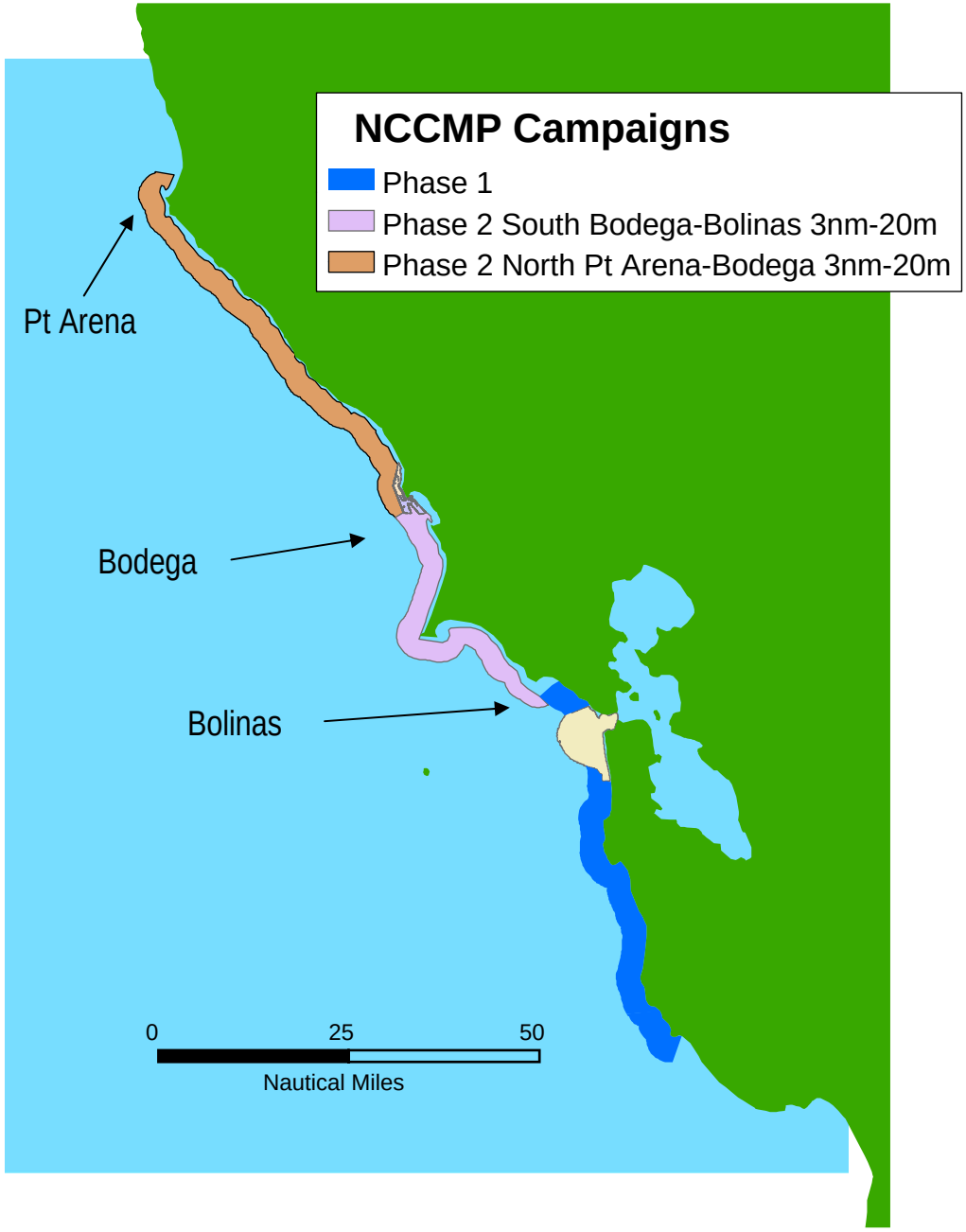
Slope Analysis



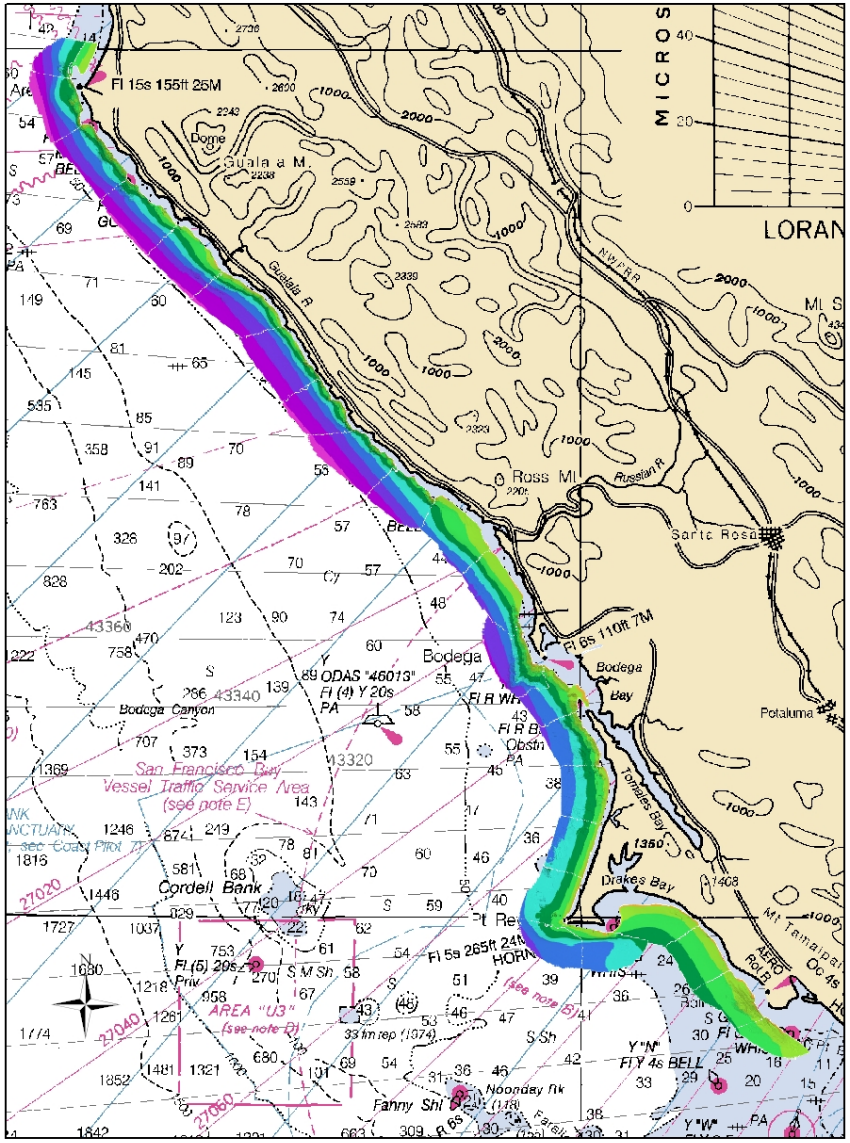
Backscatter Mosaics



MLPA Habitat Supervised Auto-Classification Depth x Substrate


NCCMP Campaigns
Phase 1
Phase 2 South Bodega-Bolinas 3nm-20m
Phase 2 North Pt Arena-Bodega 3nm-20m
Pt Arena
Bodega
Bolinas
0
25
50
Nautical Miles

NCCMP Phase 2 (3nm-20m) Multibeam Bathymetry



NCCMP Phase 2

3nm – 20 m isobath

Acoustic surveys & processing completed by Fugro

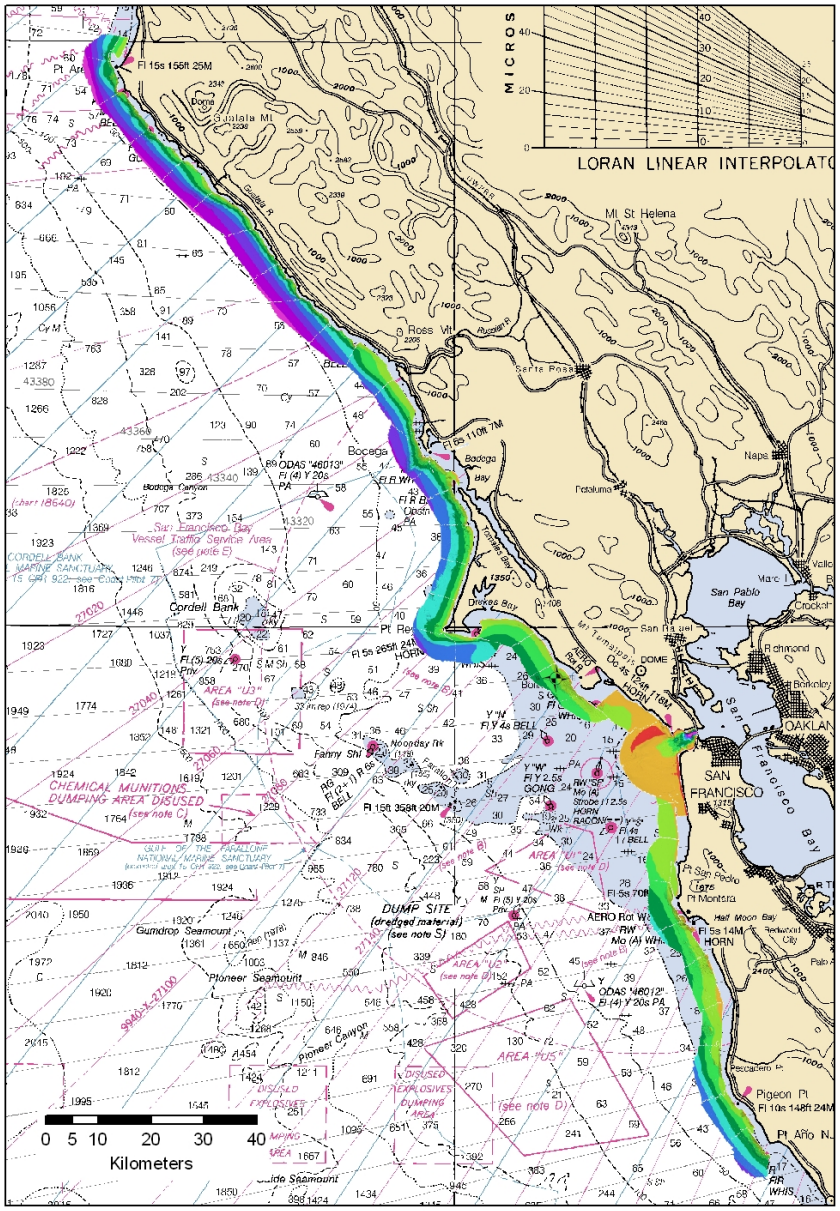
Spring 2007

Preliminary Tier 1 products delivered

(23 GB)

July 2007

NCCMP Phase 1 & 2
Multibeam Bathymetry Coverage



NCCMP Phases 1 & 2

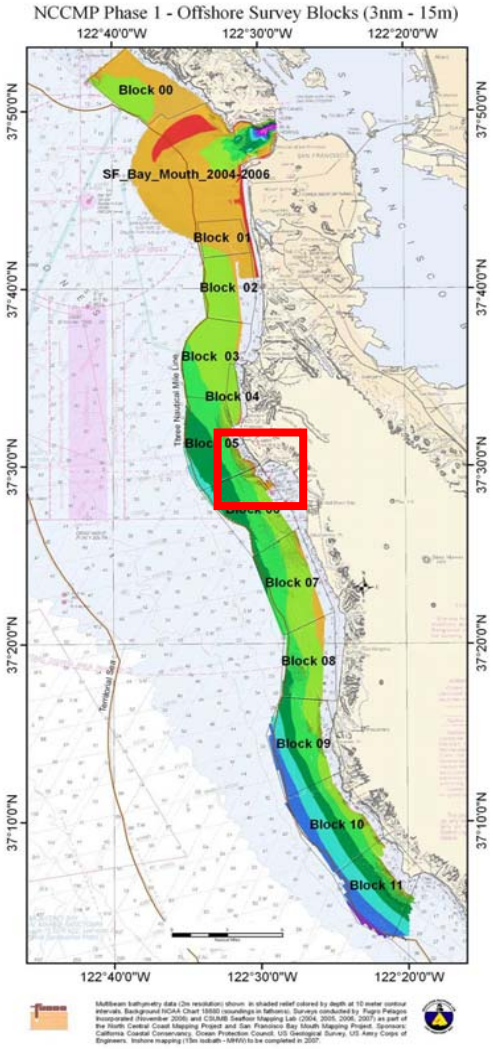
Mapping Coverage to Date

Coast line: 290 km

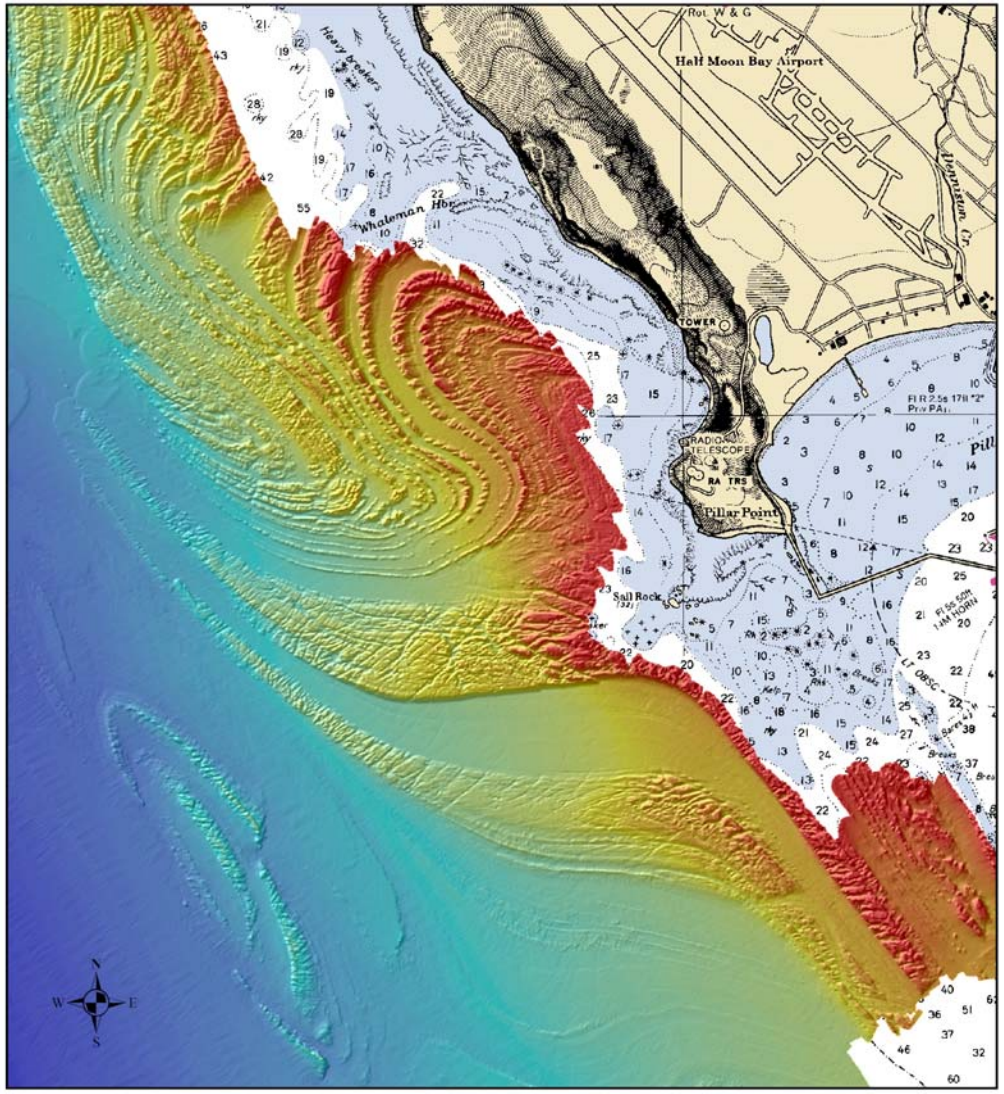
Area: 460 nm^2

Total data volume: 3 TB

Was the $3.5m NCCMP a good investment?



Mavericks Surf Sight – Half Moon Bay, Ca



Monterey County The Herald

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

State short on educated work force

REPORT: ECONOMY CAN'T RELY ON GRADUATES FROM AFAR

DEEP-SEA SIGHT

SCIENTISTS PEER UNDER WAVES TO MAP OCEAN FLOOR

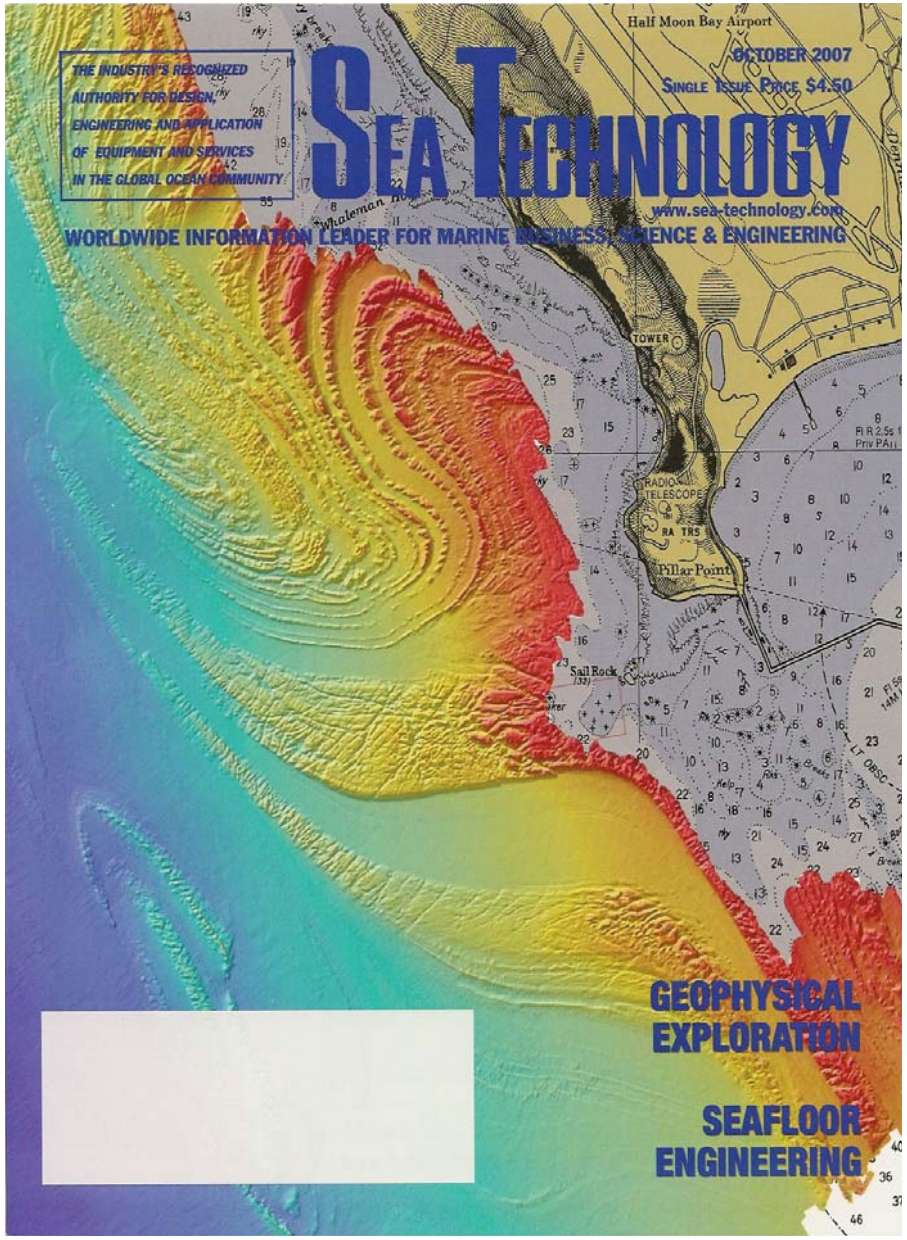
Top officials forge new Iraq policy

Pajaro agency loses on appeal

WATER DISTRICT MAY HAVE TO REFUND $4M

California Newspapers

Spring 2007



Cover of Sea Technology

October 2007

ENVIRONMENT

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.*

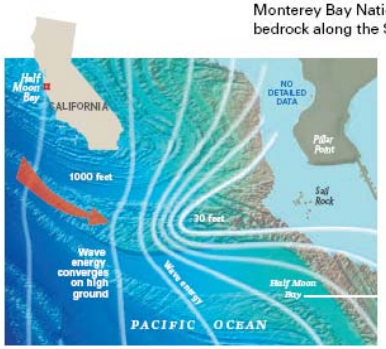


PHOTO: KEVIN GERMAN, SACRAMENTO BEE. NGM MAPS

NATIONAL GEOGRAPHIC

Magazine

The New York Times

January 2008

PBS

Television

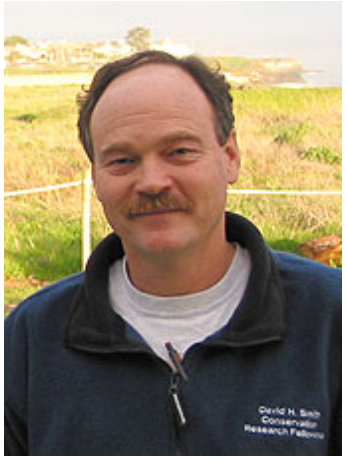
NCCMP

Marine Life Protection Act

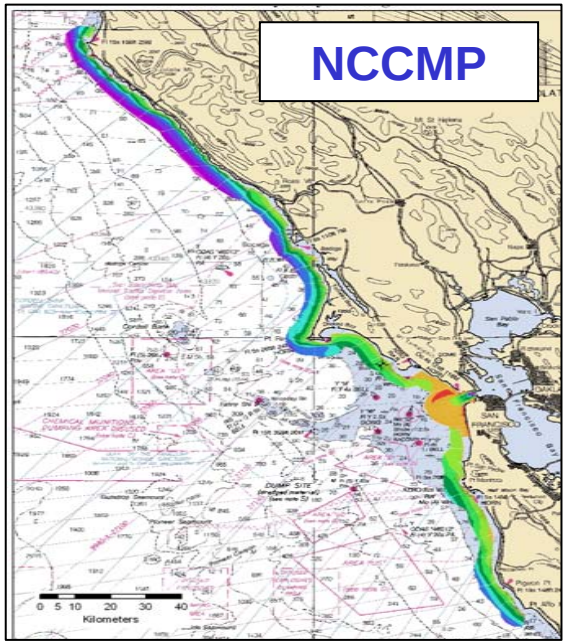
Requires California to designate a network of **Marine Protected Areas** (MPAs)

MPA Design

October 2007



"The new NCCMP 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 ($2m)

September 2007

"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

What (who) made these data so valuable to the MLPA?

Marine Life Protection Act

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

Gina Wade

MiRa Park

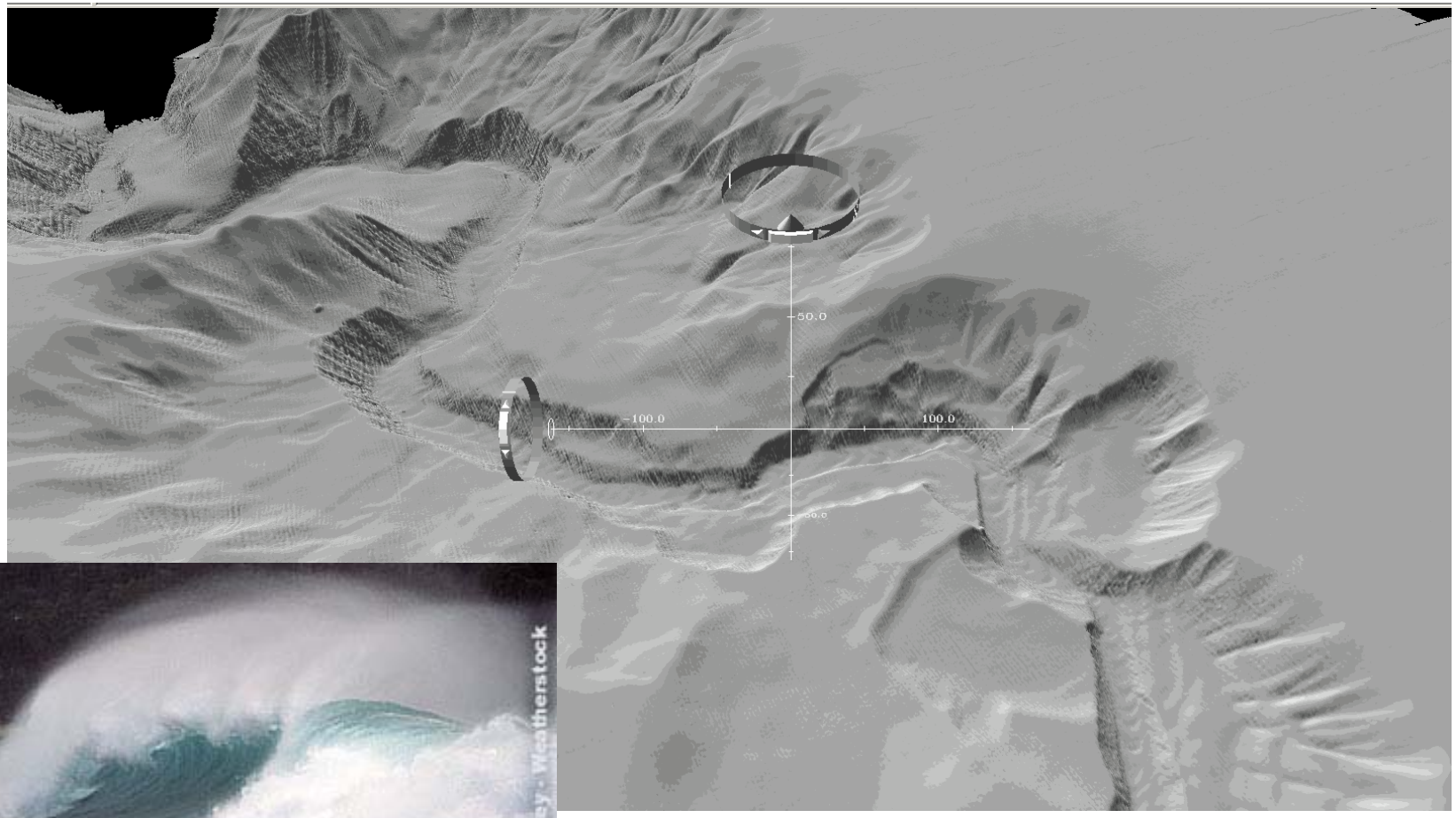
Entire DFG & MLPA GIS Lab Staff
All CSUMB/SFML Geospatial Technology Graduates

Paulo Serpa

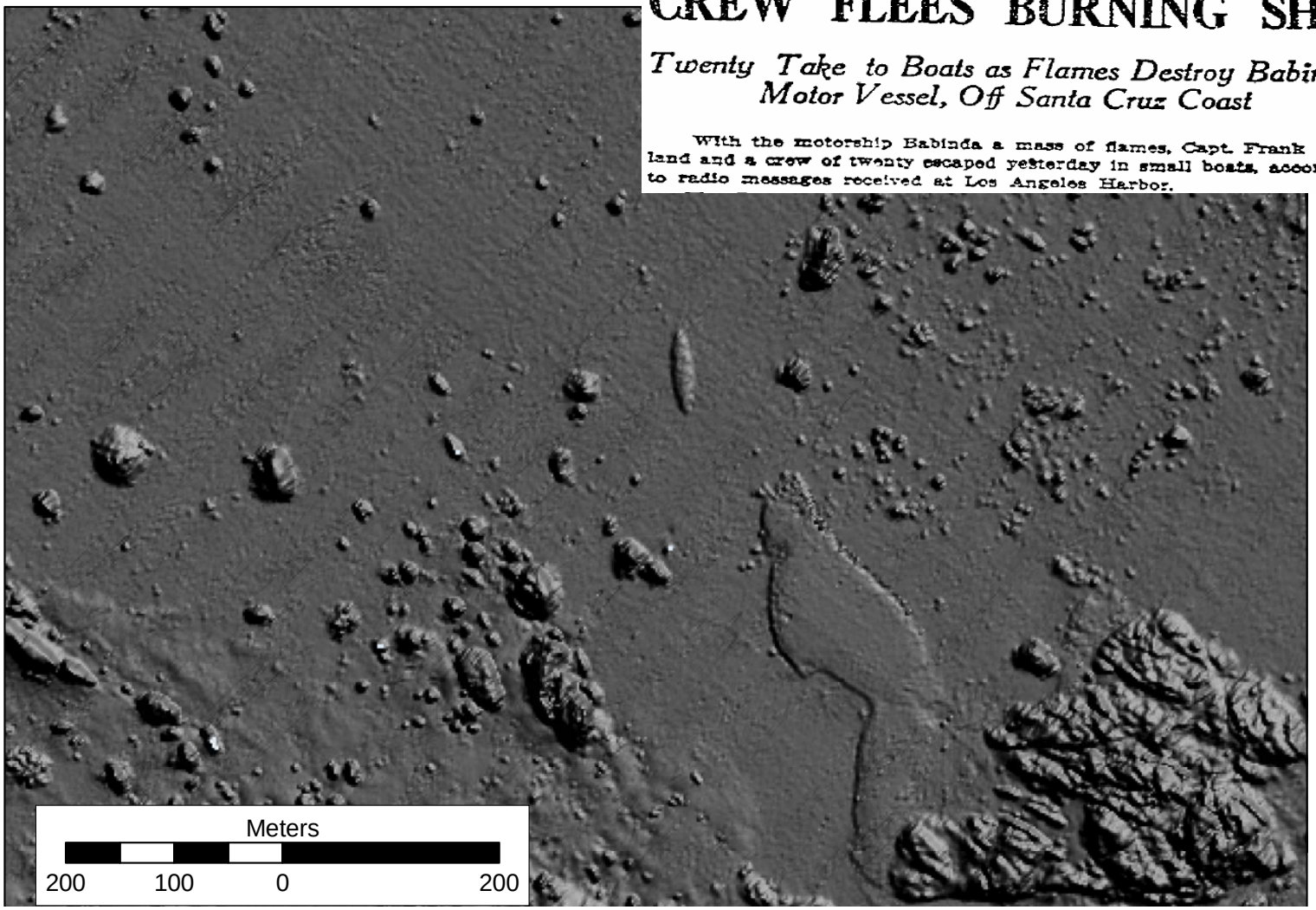
Matt Johnson

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

Tsunamigenic Landslides in Submarine Canyons



Discovering Historic Ship Wrecks



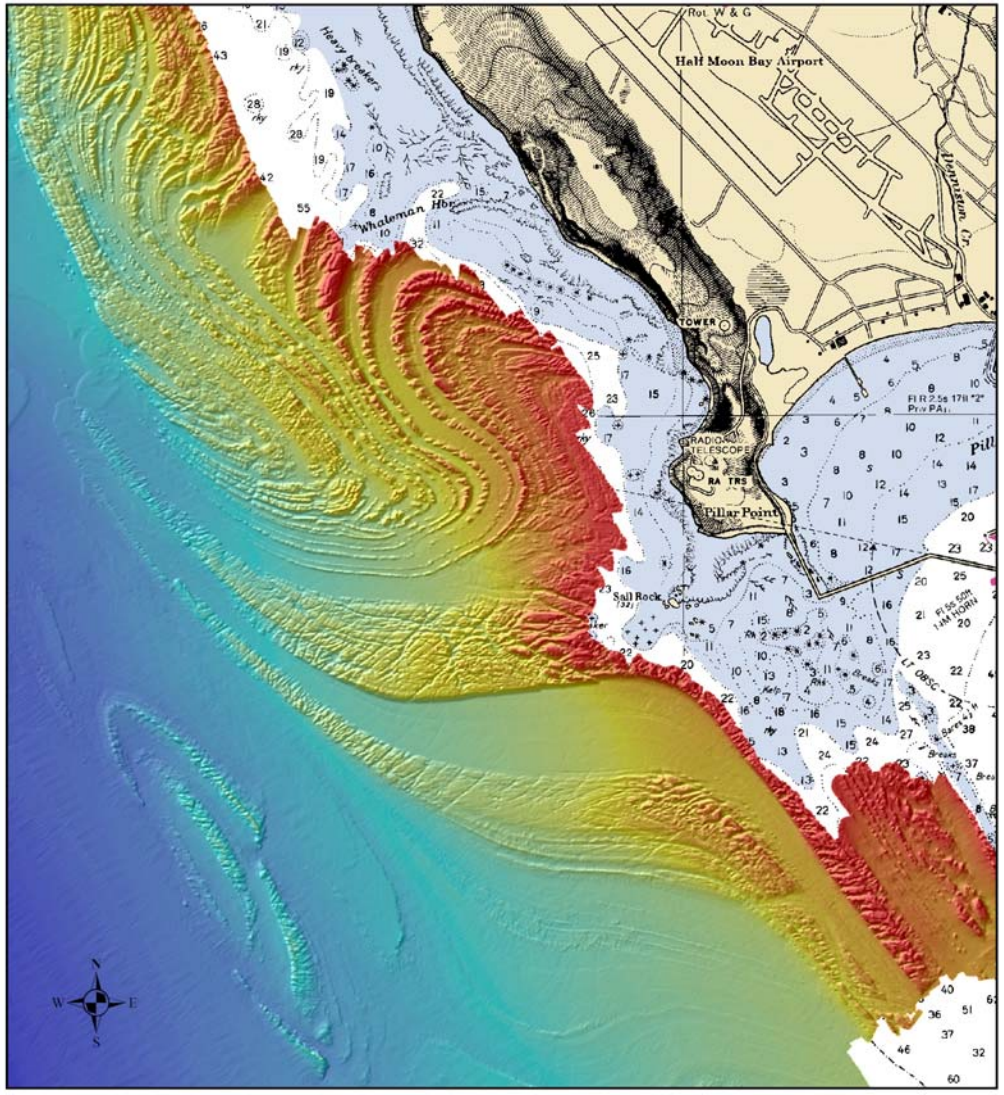
CREW FLEES BURNING SHIP
Los Angeles Times (1886-Current File); Mar 4, 1923; ProQuest Historical Newspapers Los Angeles Times (1881 - 1985)
pg. 17

CREW FLEES BURNING SHIP

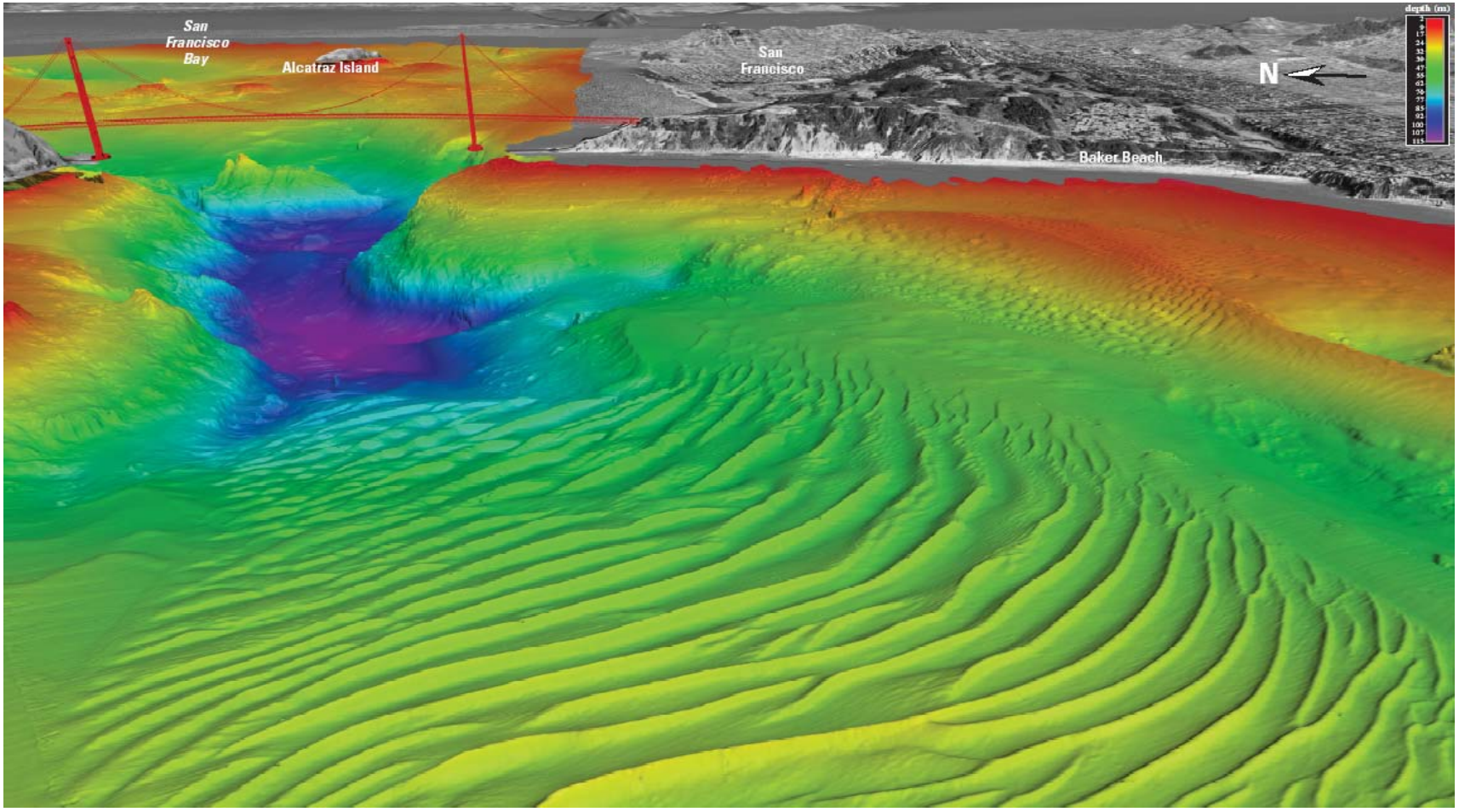
Twenty Take to Boats as Flames Destroy Babinda, Motor Vessel, Off Santa Cruz Coast

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

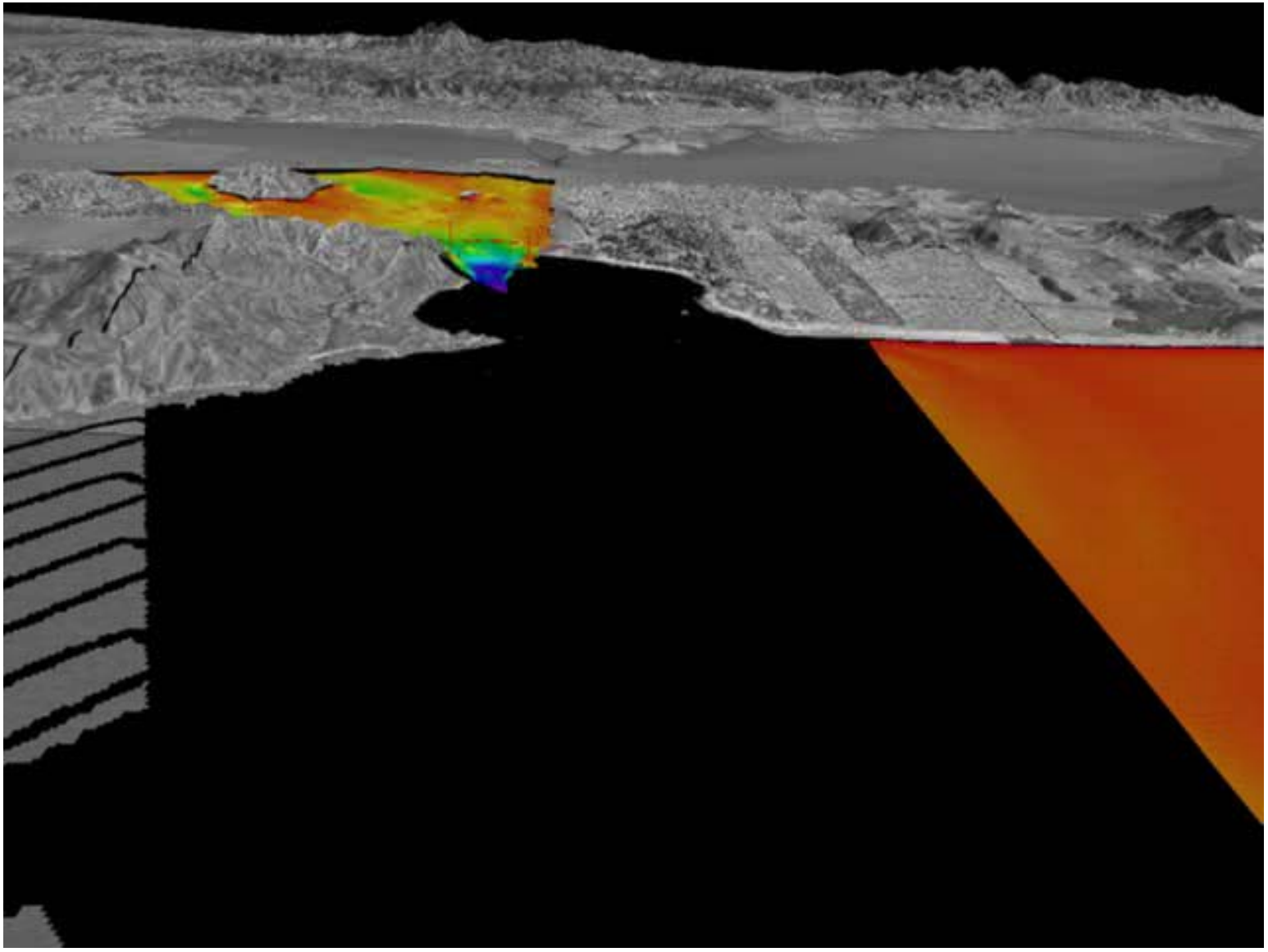


Migrating Dune Fields & Sand Transport



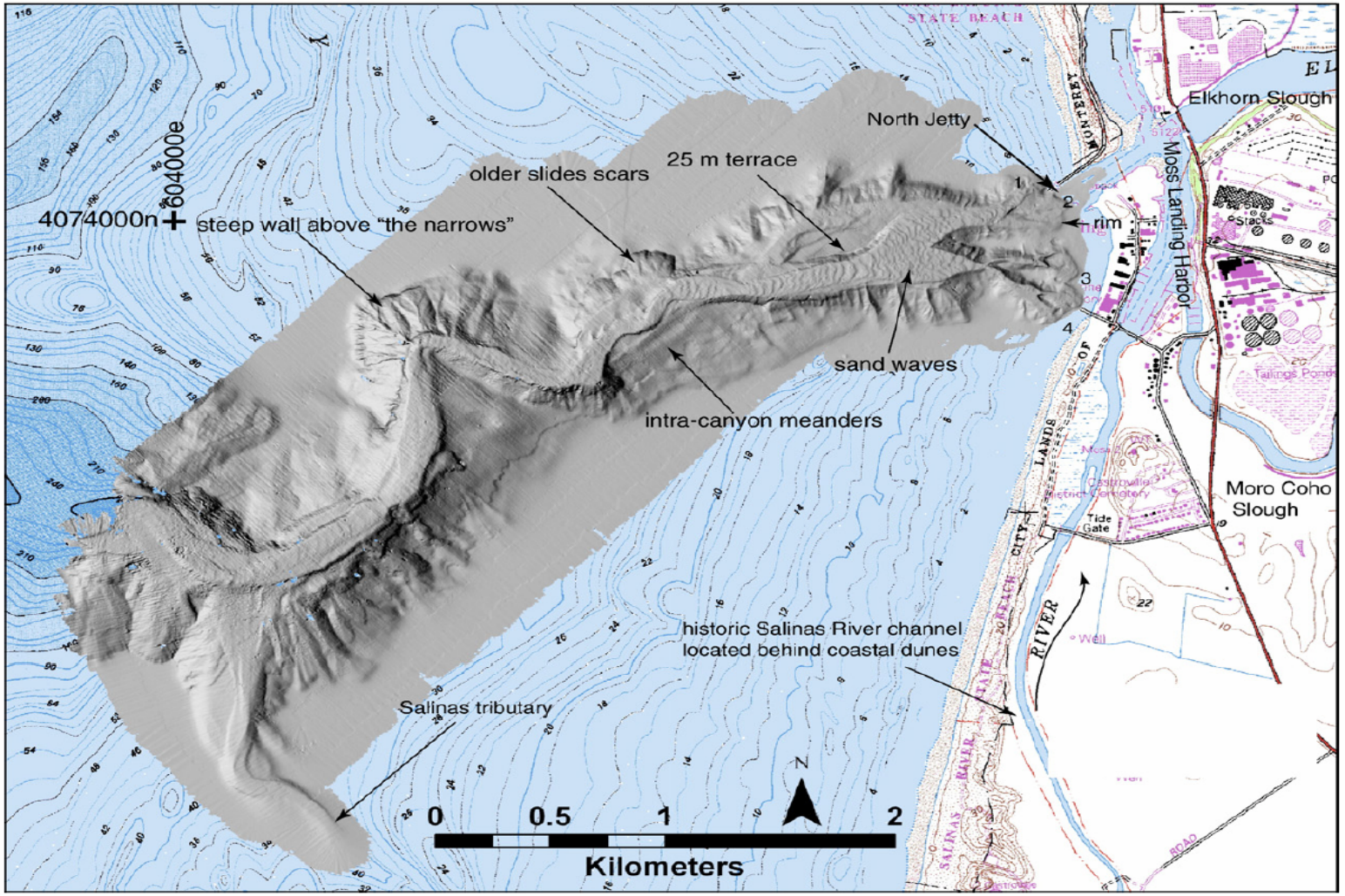
Modeling currents, sediment transport & coastal erosion

Maintaining SF Golden Gate & Ocean Beach



Patrick Barnard - USGS

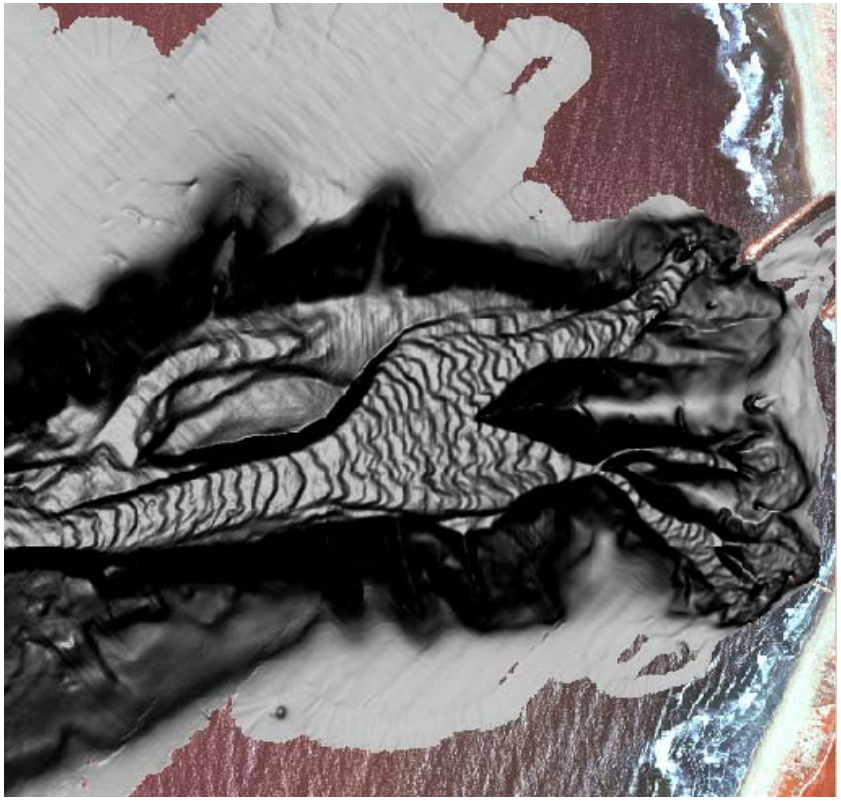
Base Map for Environmental Change Detection



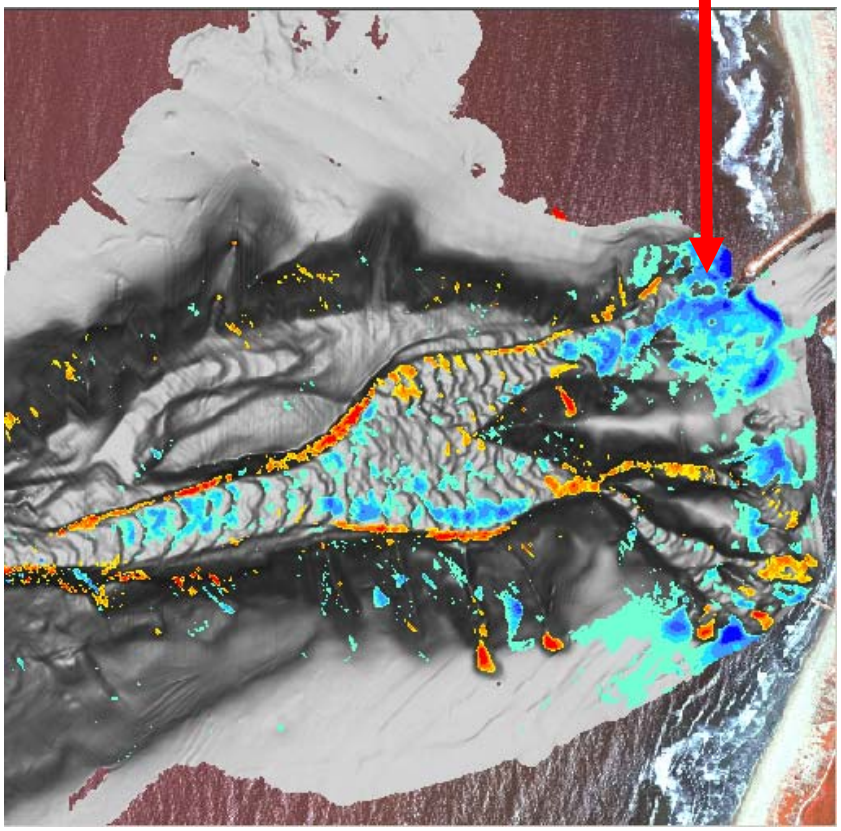
Repeat Mapping = Habitat Change Detection

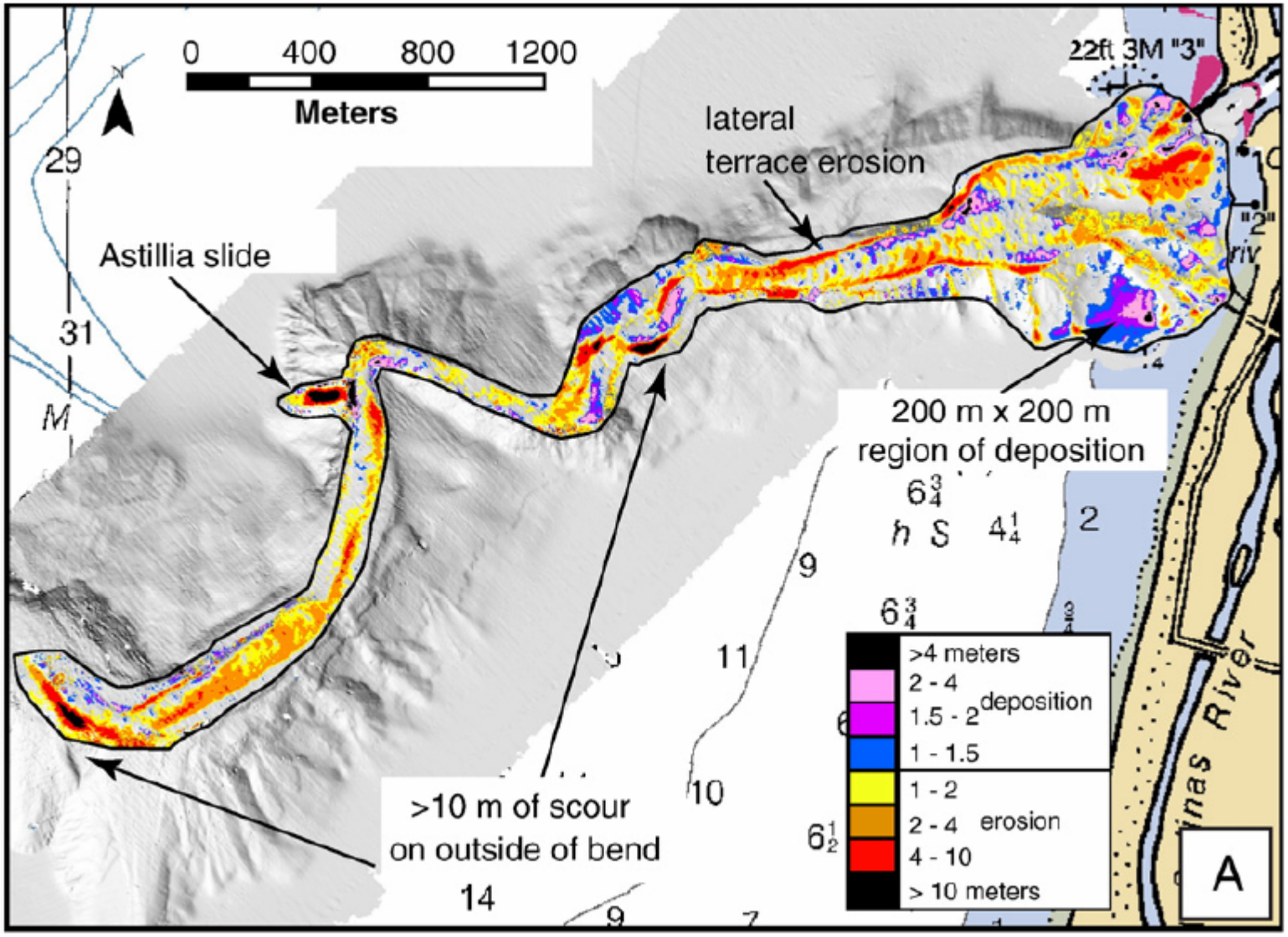
Sediment accumulation

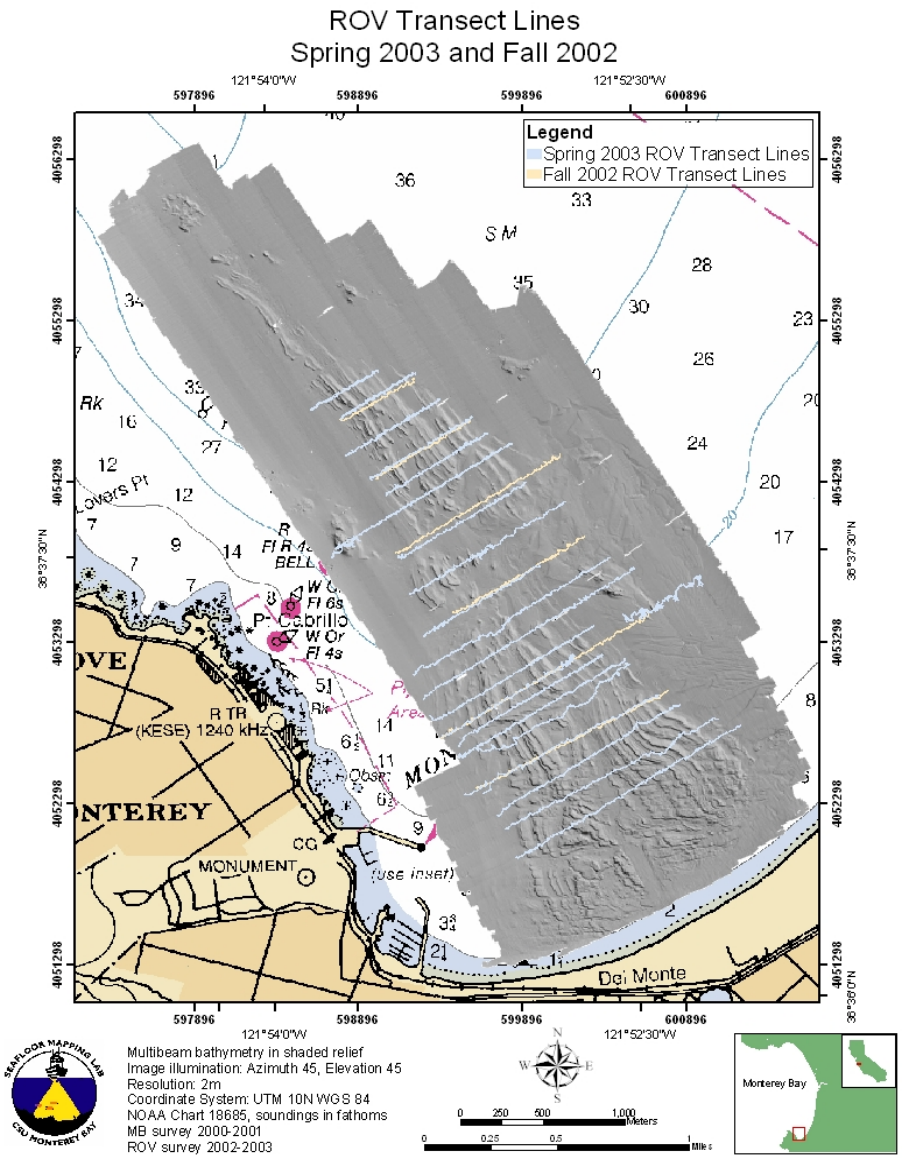
Fall



Spring

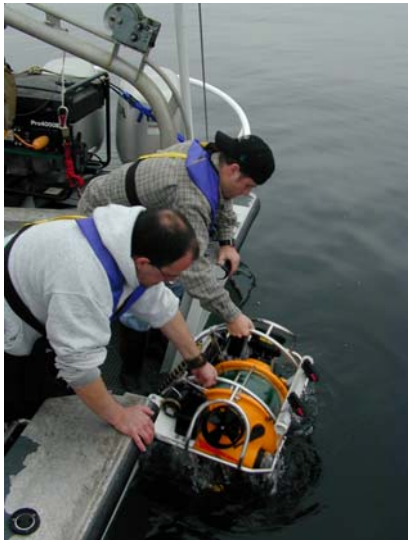



0 400 800 1200
Meters
lateral
terrace erosion
Astillia slide
200 m x 200 m
region of deposition
>10 m of scour
on outside of bend
>4 meters
2 - 4
1.5 - 2
1 - 1.5
deposition
1 - 2
2 - 4
4 - 10
> 10 meters
erosion
A

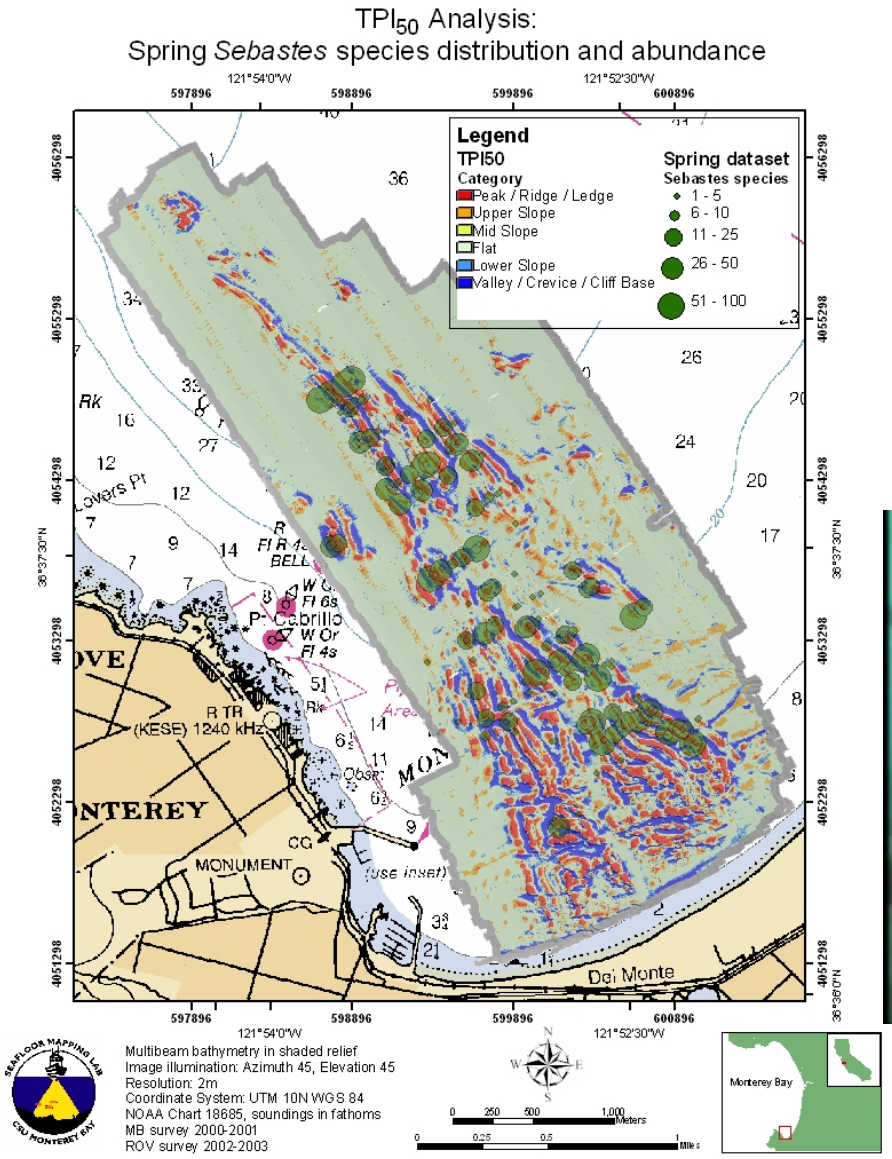


Species-Specific Habitat Maps
Fish Stock Assessments
&
MPA Suitability Modeling

Video Mapping
Rock Fish distribution
with
ROV

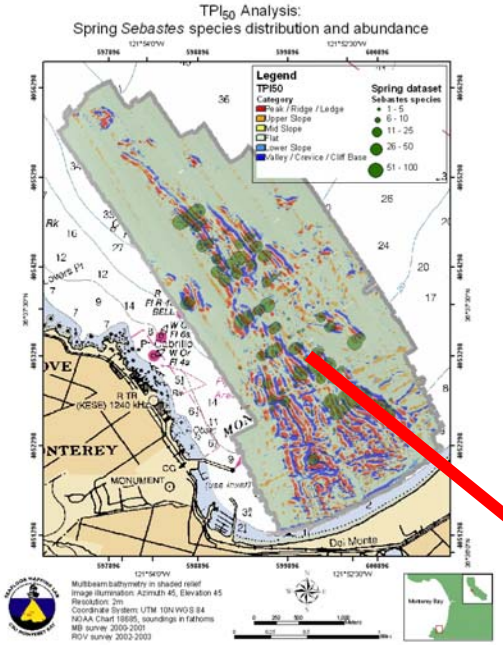


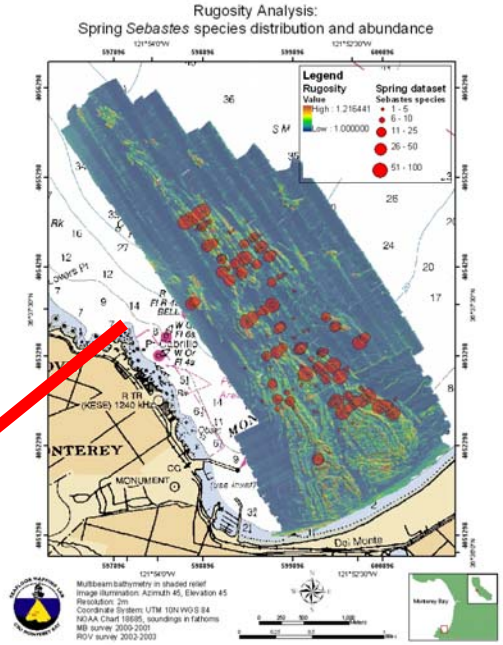
Multivariate Landscape Models & Species Distribution Data



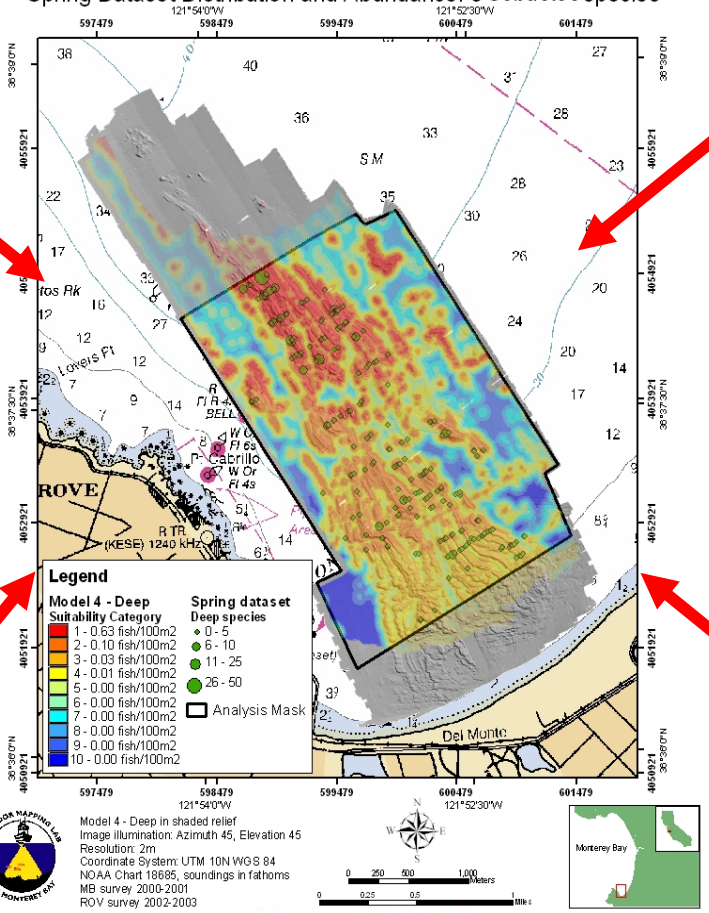
Predicted Fish Distribution

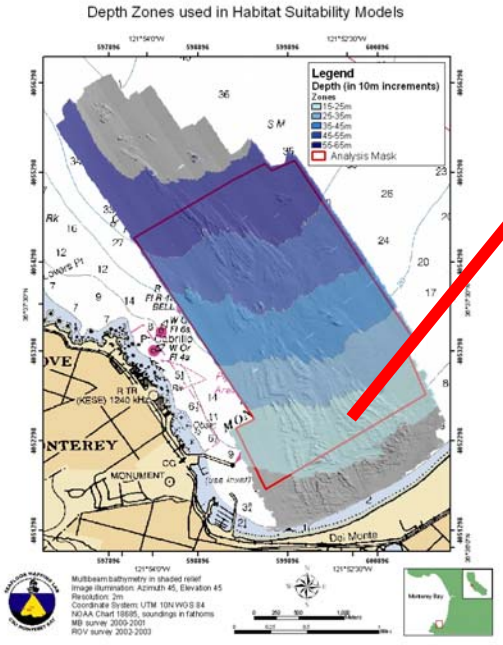
“Deep” species model

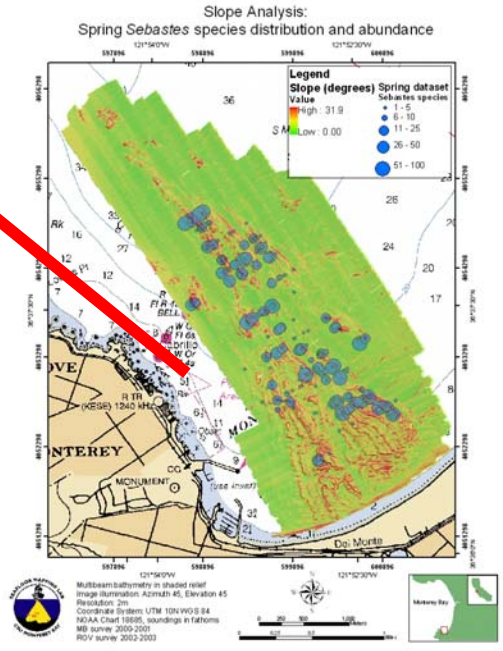




Model 4 - Deep
Distance to Optimal - TPI_{50} Peaks + Slope + Rugosity + Depth
Spring Dataset Distribution and Abundance: 3 *Sebastes* species

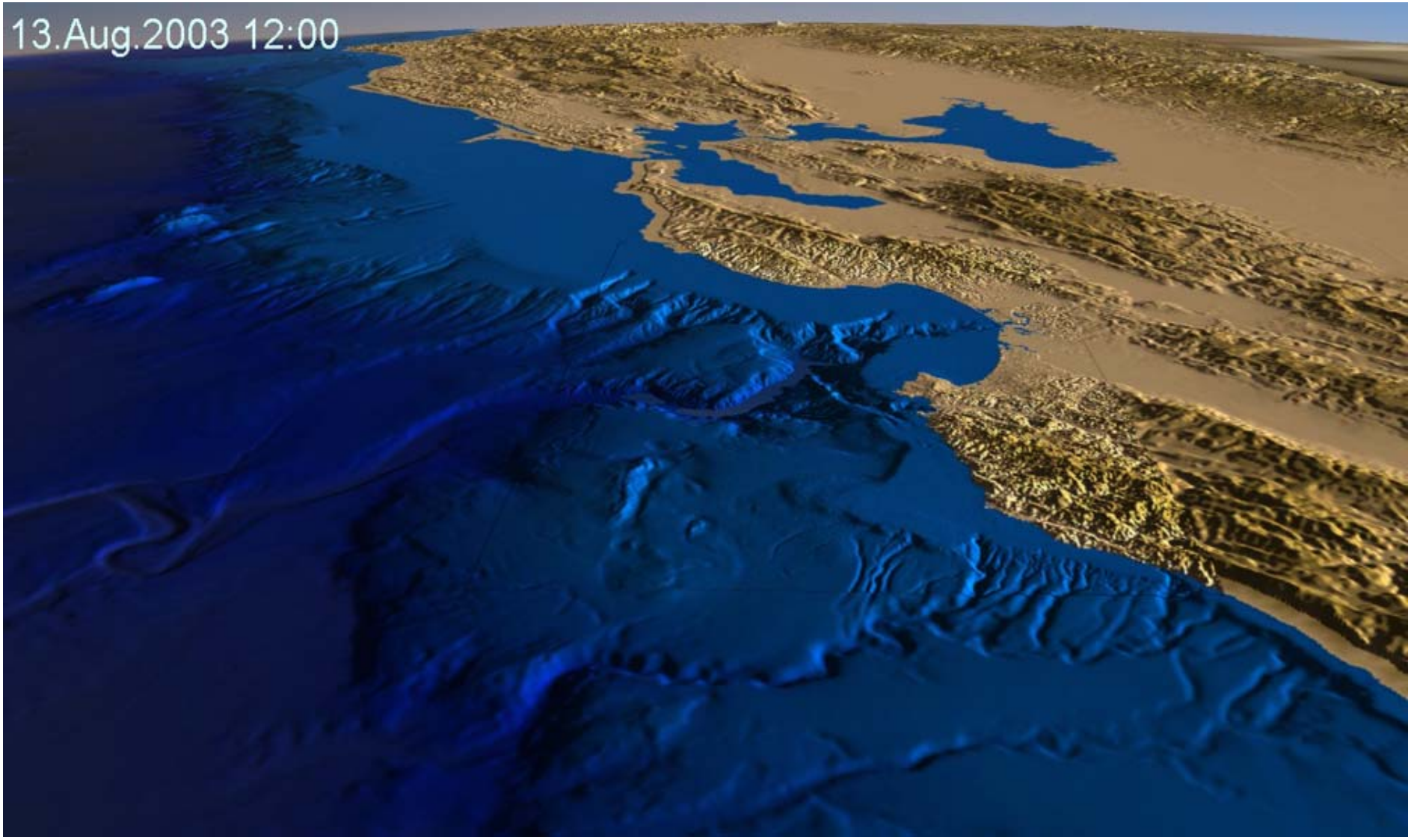






Coastal Ecosystem Visualization

Combining coastal terrain & monitoring data with ecosystem models



Coastal Ecosystem Visualization

Combining coastal terrain & monitoring data with ecosystem models

California's State Waters Remaining After NCCMP:

State Waters – Mapped 33%

State Waters – Not Mapped 66%

9000 km^2 to go

State Waters = 3 nm - shore

That's why these students are smiling.

Rikk Kvitek

Supporting marine stewardship through science, technology & education

http://seafloor.csumb.edu

Rikk Kvitek

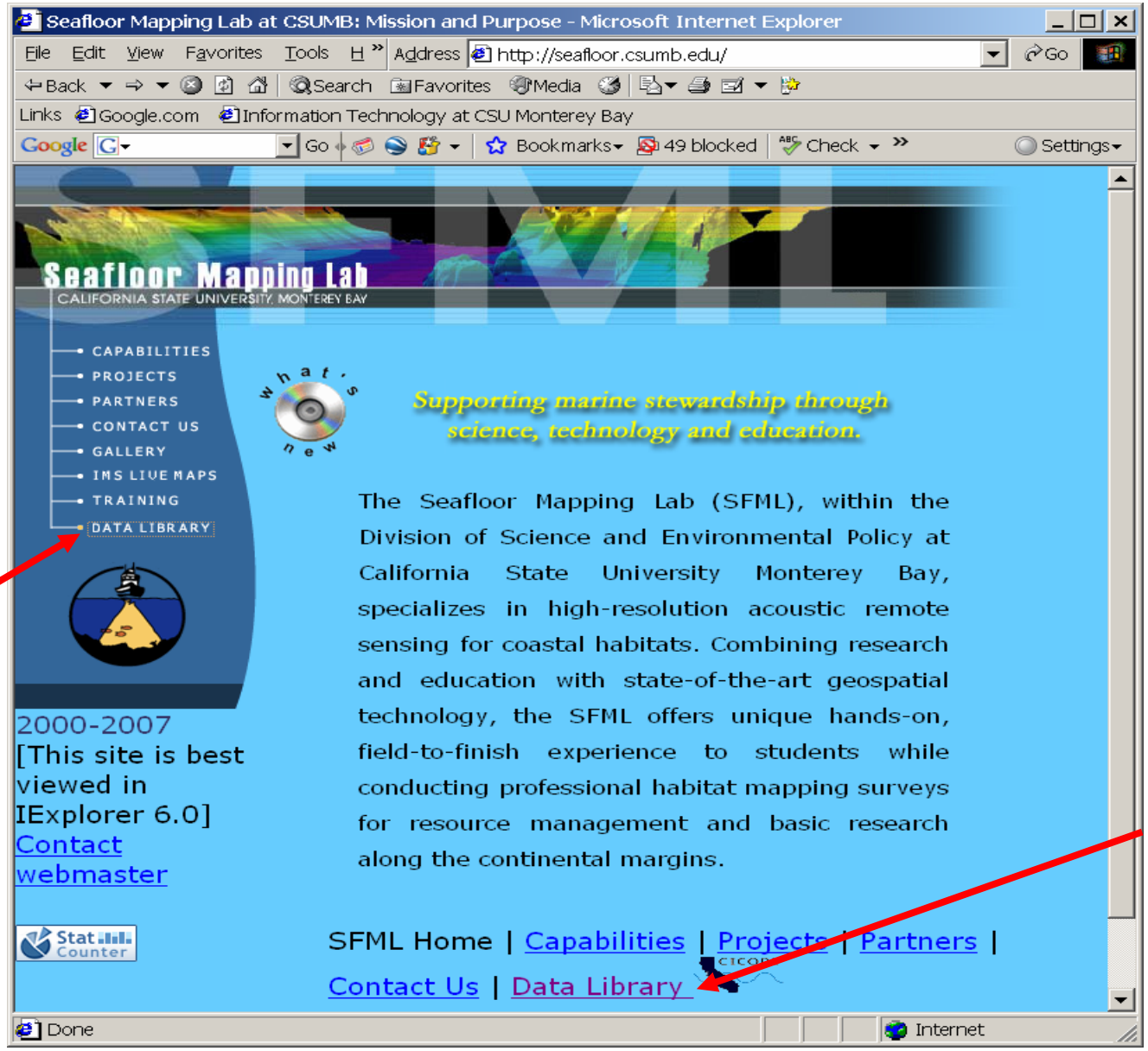
Supporting marine stewardship through science, technology & education

http://seafloor.csumb.edu

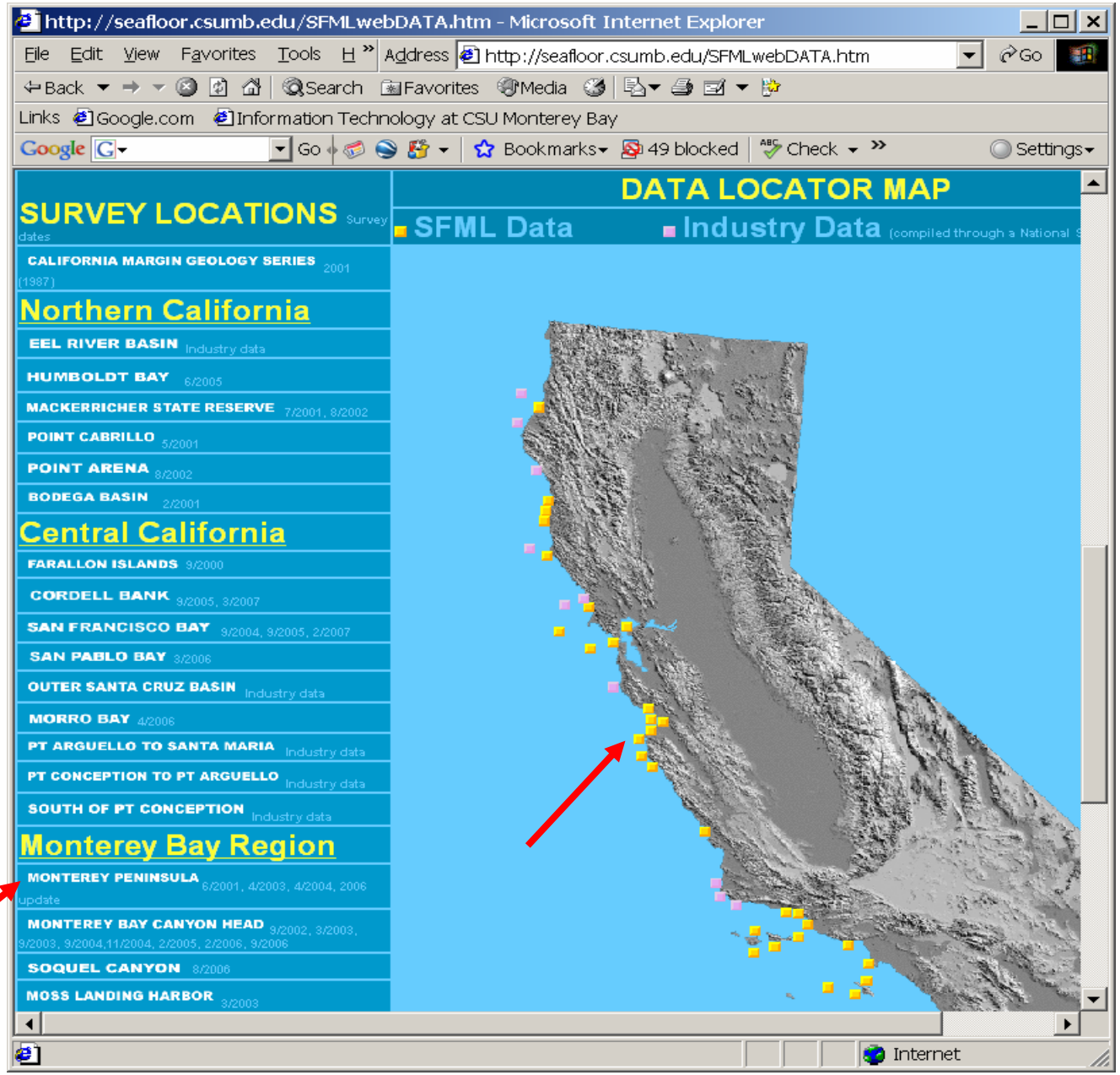
Will you be able to access the products online?

Several approaches planned and being explored.

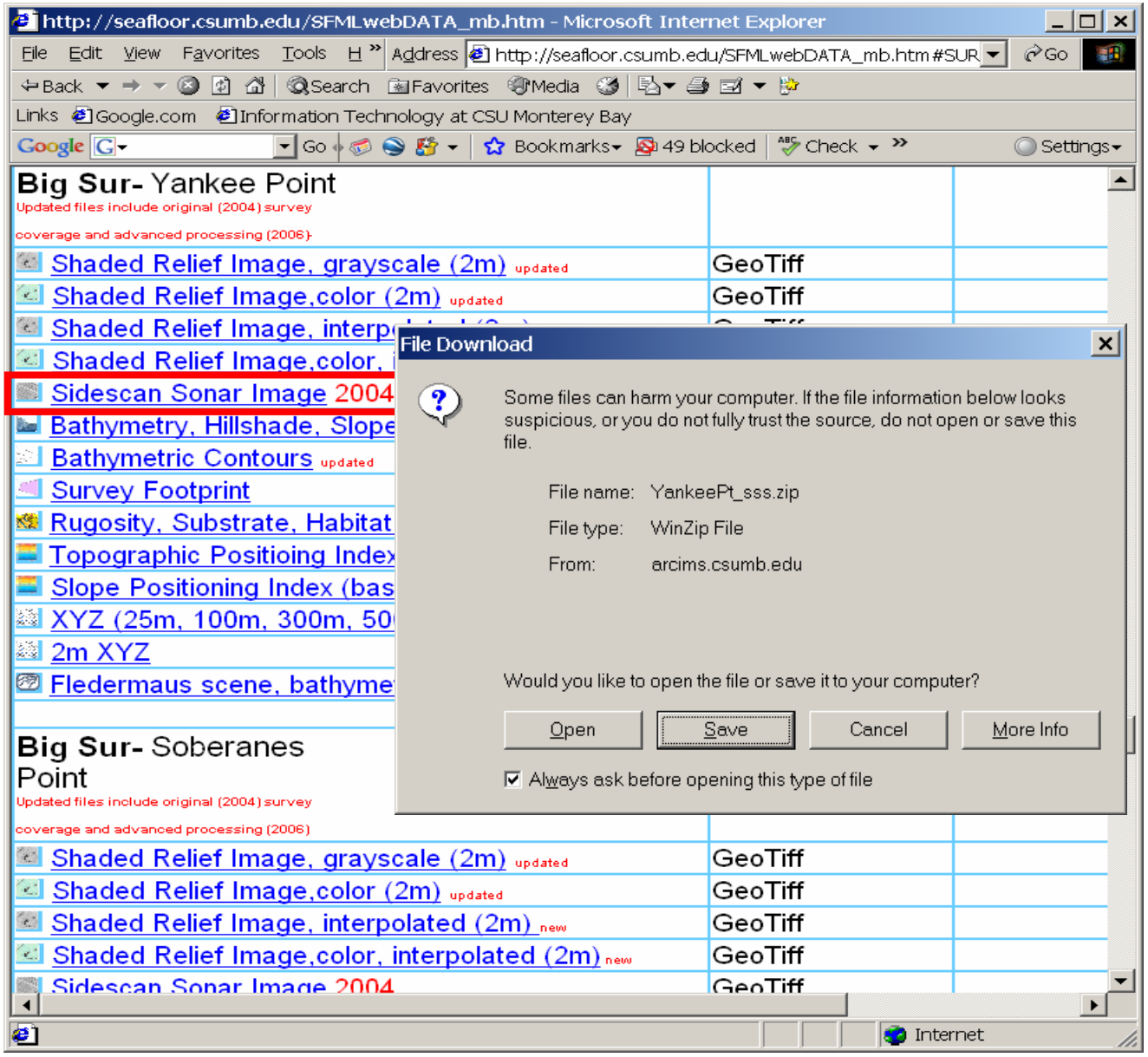
CSUMB Seafloor Mapping Lab: http://seafloor.csumb.edu



CSUMB Seafloor Mapping Lab: http://seafloor.csumb.edu



CSUMB Seafloor Mapping Lab: http://seafloor.csumb.edu



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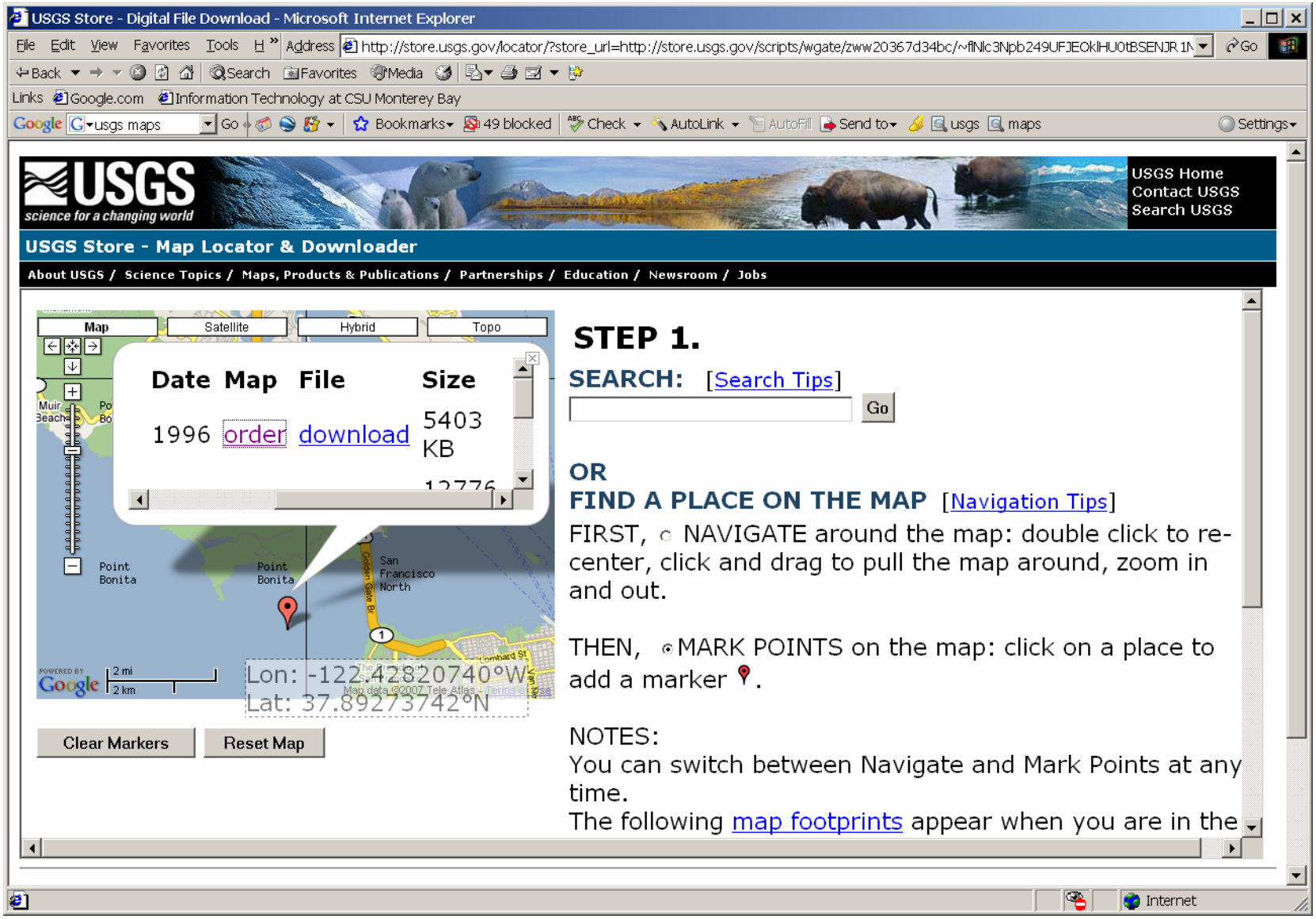

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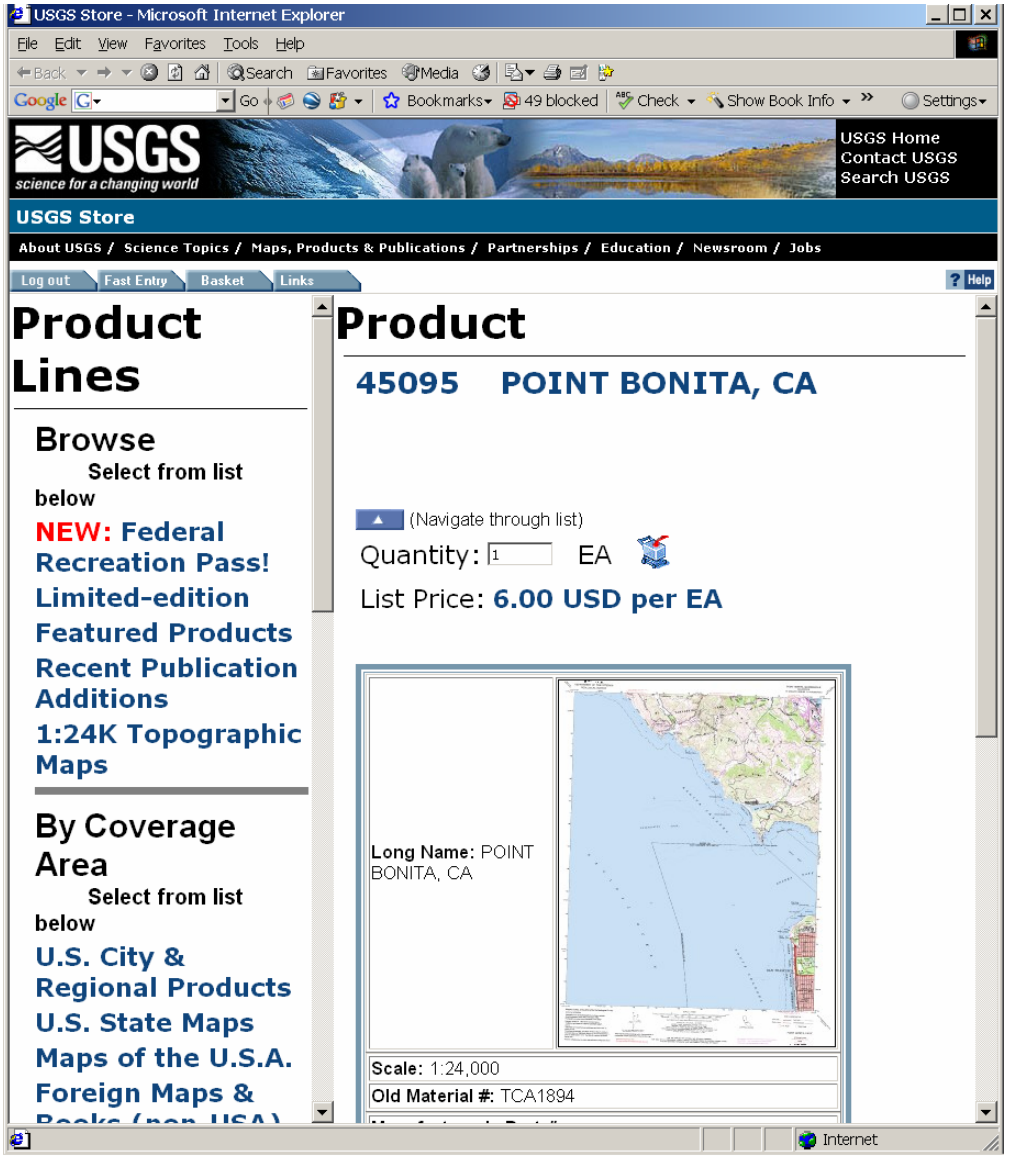
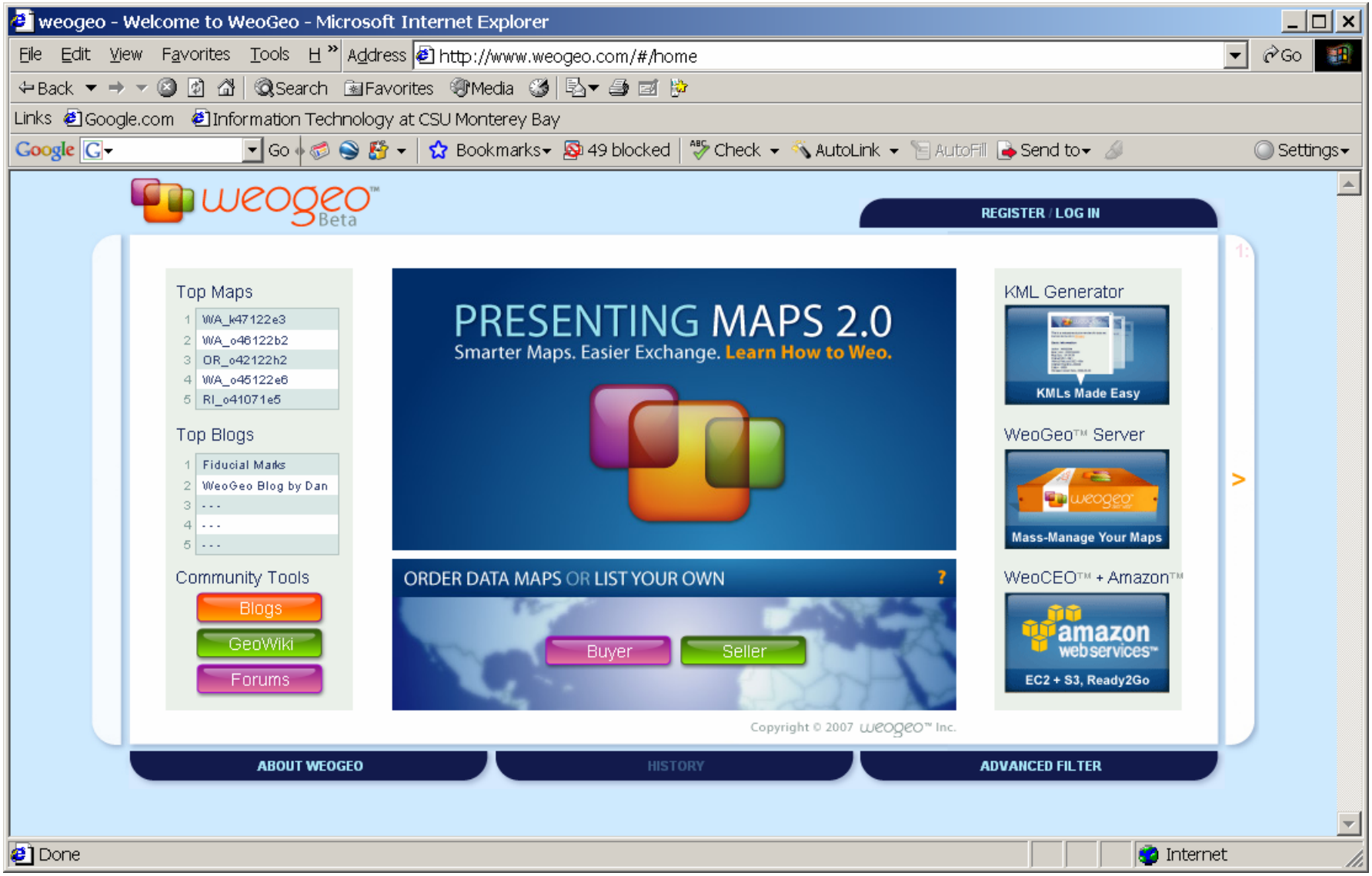


weogeo: http://weogeo.com



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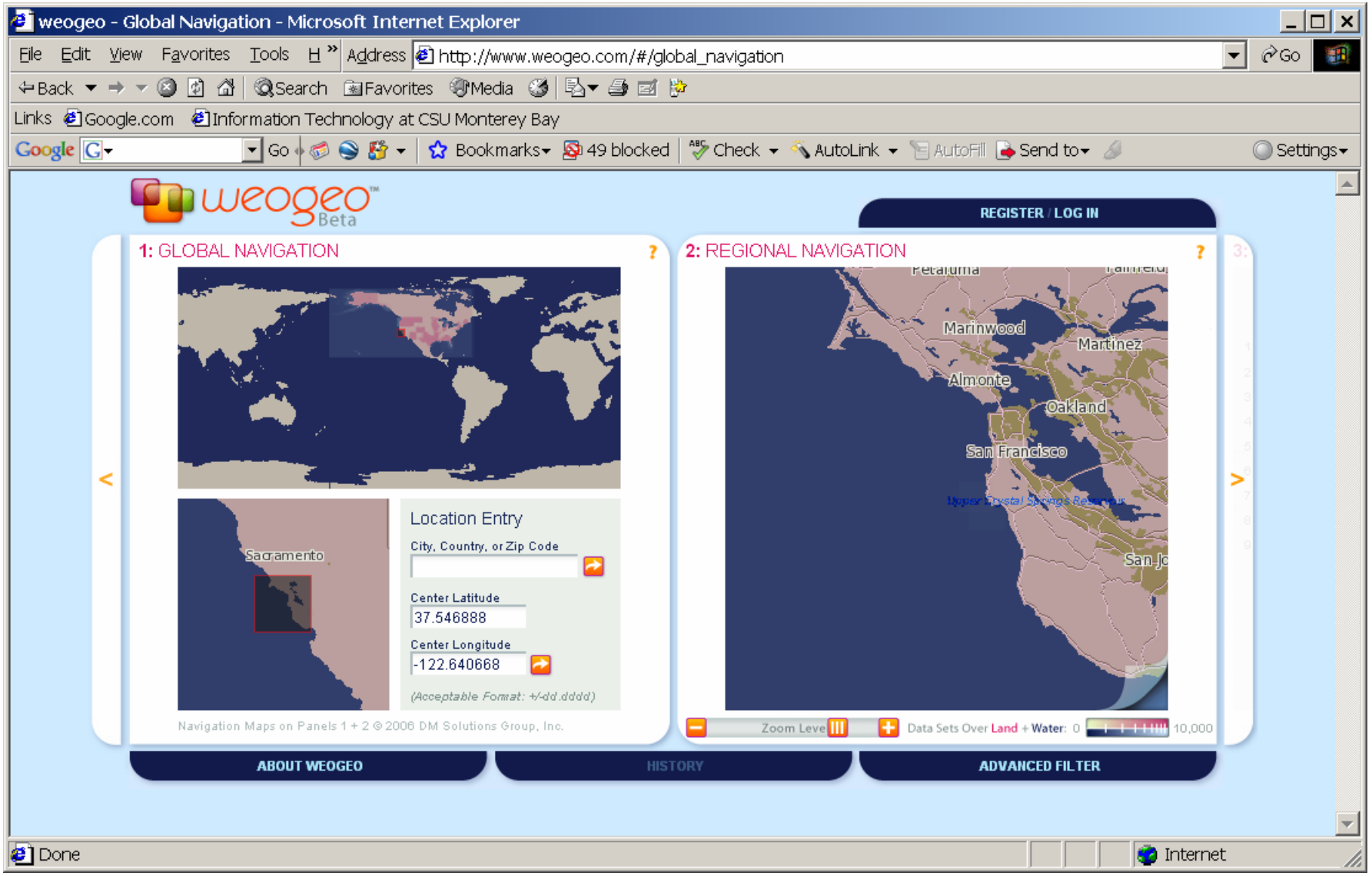

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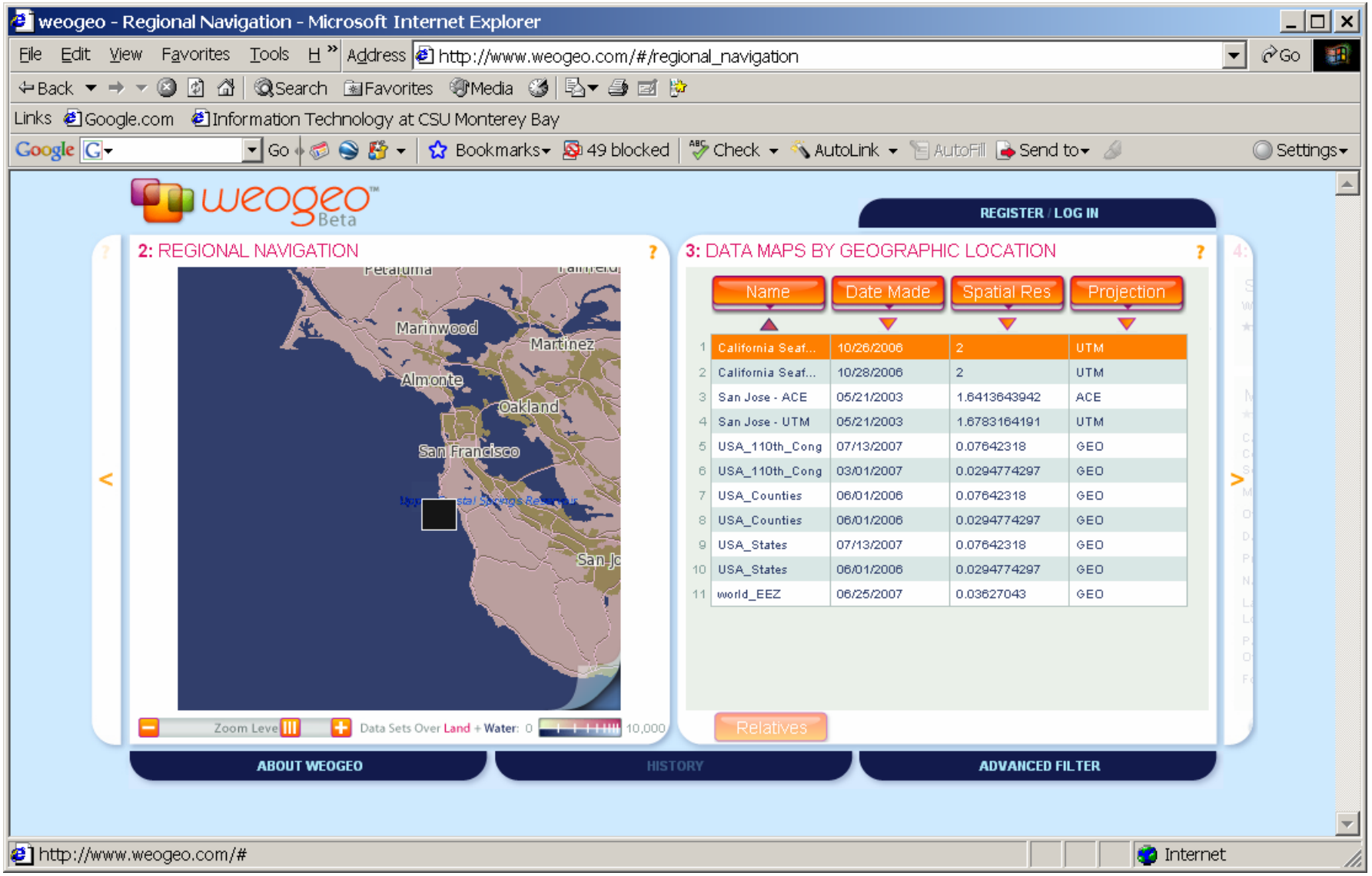

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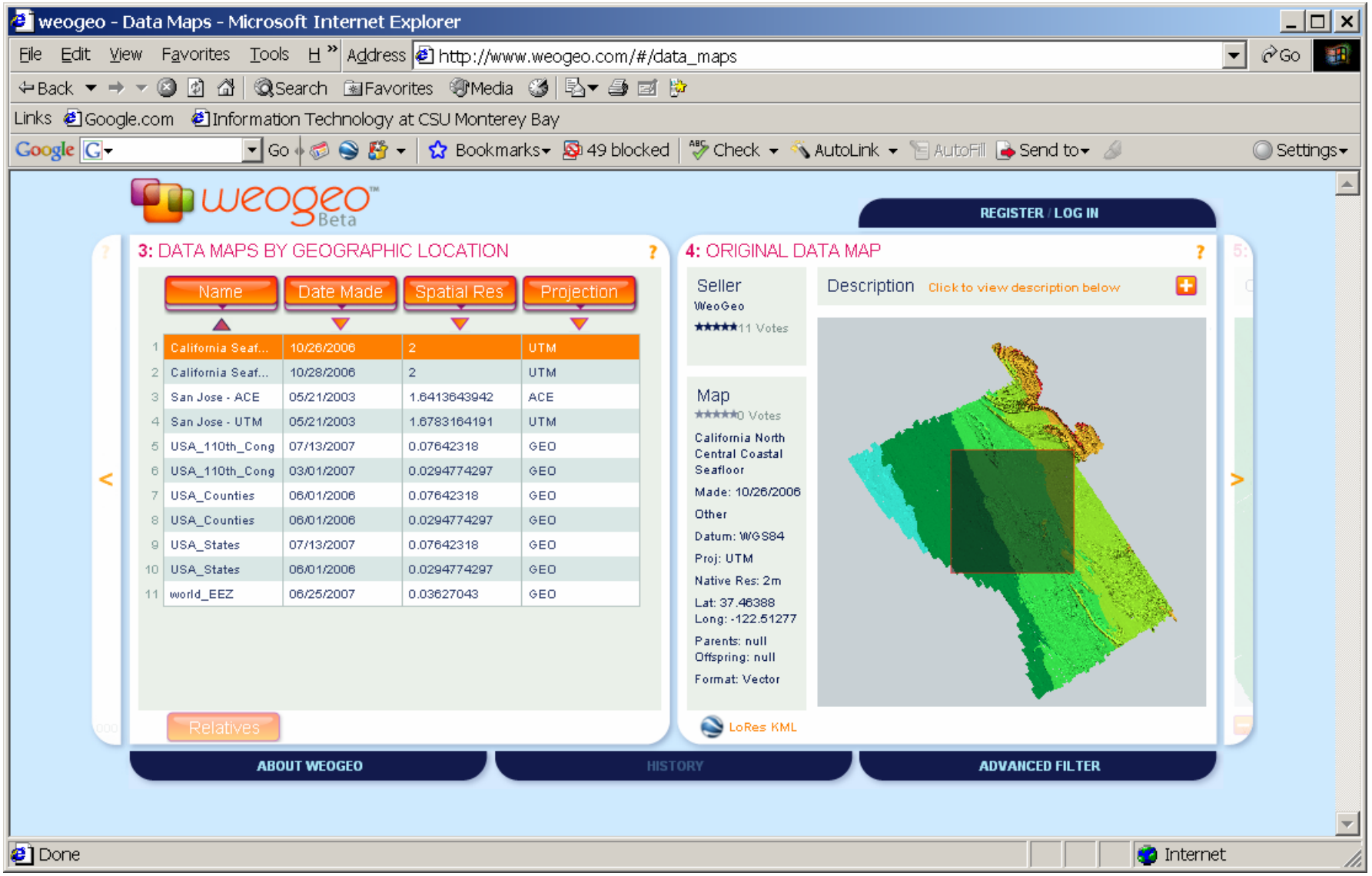

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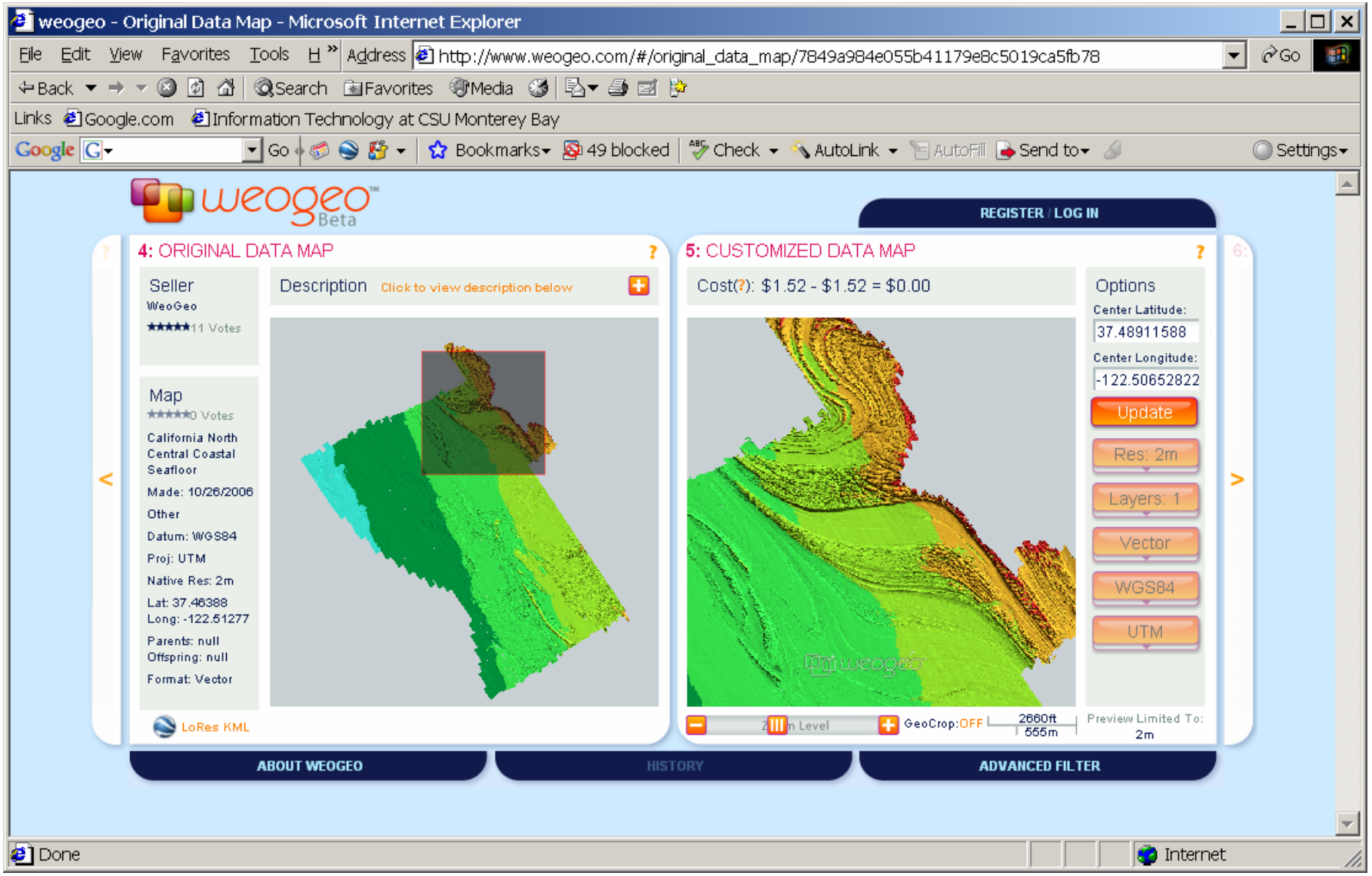

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