"Exploring California’s Ecological Changes and Historical Origins"

**R/V Melville**

Scripps Institution of Oceanography at University of California, San Diego  
September 25 – October 3, 2010

A University of California Ship Funds Research and Outreach Cruise  
Chief Scientist: Mindi Summers (msummers@ucsd.edu)

**California’s Time Capsule and Window into the Future.** The Santa Barbara Basin is an ideal location to explore California’s natural history and ecological diversity both on the land and in the ocean. Since the last glaciers began their retreat from North America around 15,000 years ago, the ecosystems of California have experienced dynamic changes. Periods of cold temperatures brought forests more than 3000 feet lower than today, while hotter times allowed desert scrub to dominate all the way to the coast. Mammoths, lions, giant ground sloths, and camels went extinct and changes in sea level altered the distribution of reefs and kelp forests.

Annual sediment layers have recorded these changes in the Santa Barbara Basin. As layers are deposited, terrestrial and marine organic materials like ash, pollen, fish tooth and scales, marine phytoplankton, and DNA intermingle with the sediment. Since the Santa Barbara Basin is almost void of oxygen and burrowing organisms, these annual layers act like tree rings to preserve information about past ocean chemistry, biological diversity, and land ecosystems. It may even be possible to extract the DNA from organisms that perished more than 11,000 years ago at the end of the last glacial period.

On shorter timescales, the 20th century experienced the collapse of major coastal fisheries, like the Monterey sardine industry, and changes in the members of the marine community in response to climate forcings like El Niño. Fish scales from the Santa Barbara Basin allowed the boom and bust cycles of sardines and anchovies to be linked to their crash after WWII. Since 1949 California Cooperative Oceanic Fisheries Investigation (CalCOFI) has been sampling the biological fauna of the basin providing a yearly record of many organisms not usually preserved in sediment accumulations but especially important economically.

Overall, the continuous change in environmental conditions over the past 11,000 years makes the basin an interesting site to study community dynamics and change—and uncover the historical origins of such change to predict the future of California’s marine and coastal ecological communities.
**Scientific Goals.**

1. **Ancient DNA:** Search for the presence of ancient “fossil” DNA to study ecosystems during the climate fluctuations from the Last Glacial (~12,000 years ago) to today.

2. **Marine Food Chains:** Investigate multiple levels of the marine food chain inside and outside of the anoxic areas of the Santa Barbara Basin through tows and sediment-hosted fossilized remains. Microbes, zooplankton, mesopelagic fish, squid, marine mammals, and seabirds will be studied in terms of diversity (genetic and metabolic), the effect of climate and environmental changes, and the role of fishing biologically and economically.

3. **High resolution 2000 year record:** Investigate changes in fire history, flora, and sedimentary environment over the past 2000 years in respect to human habitation of the coast and climatic changes.

4. **Bioacoustics:** Develop and test non-invasive acoustic techniques of measuring the presence and abundance of zooplankton.

5. **Fisheries Economics:** Create economic tools to help manage fisheries in a multispecies framework.

6. **Paleomagnetism:** Use patterns in the magnetic properties of the sediments of the Santa Barbara basin to infer important information about climate and how it has changed.

7. **Deep Sea Fauna:** Explore different benthic communities from oxic to anoxic zones of the basin, identifying new species and their relationships to each other and the environment.

8. **Paleogenetics:** Compare the genetic record of key species (sardines, anchovies, marine mammals) to the fossil record and CalCOFI datasets.

**Outreach.**

High school classrooms across California, northern Ohio, and across the country will be invited to interact with the cruise. In particular, educators from San Diego, CA and Berea City Schools, OH will work to fill curriculum gaps with Cal-ECHOES-based lesson plans, web-based learning tools, and opportunities for student participation in data analysis. Graduate students participating on the cruise will also design science fair projects incorporating cruise themes and data collection.
1. Sampling Locations

Station 1: ODP 893 Santa Barbara 33° 17’ 15" N, -120° 2' 9.6" W
water depth 575m

Shipping lanes may be an issue, requesting sampling as close as possible.

Station 2: ODP 1015 Santa Monica 33° 42' 55.44" N, -118° 49' 8.4" W
or northern sill Santa Barbara
or DSDP 467
water depth 900.8m

Figure 1. Cruise track from San Diego (32°44’N, 117°10’W) to Santa Barbara Basin (34°17.25’N, 120°02.2’W).

Figure 2. Bathymetry from Santa Barbara Basin. Monterey Bay Aquarium Research Institute multibeam data, 2001.
Figure 3. Bathymetry and sampling locations within Santa Barbara Basin. Station One is considered to be anywhere within the anoxic zone of the basin (greater than 450 m).
II. Deployments and Equipment Requests

1. Oregon State piston coring
The Oregon State piston coring facility will deploy five jumbo piston cores from two locations, one within the anoxic zone of the basin at Station 1 and one outside of the anoxic zone at Station 2. All cores will be preserved in anoxic conditions following recovery inside of the SIO 12ft temperature controlled van (4°C). One core from each site will be preserved intact, flushed with nitrogen gas, sealed, and stored in the 4°C OSU core van. One core from each site will be sub-sampled at the bottom of every 1.5m split (10 subsamples per core), sealed in liquid nitrogen and then stored in the 4°C refrigerator.

*Deployment from the starboard A-frame 9/16 wire.*
- The starboard A-frame will need to be moved aft to accommodate for piston coring.

2. Gravity cores
Eight gravity cores from each Station will be collected prior to piston coring. All cores will be preserved in anoxic conditions following recovery inside of the SIO 12ft temperature controlled van (4°C). Two cores will be stored intact, flushed with nitrogen gas, sealed, and stored in the 4°C OSU core van. Two cores from each site will be sub-sampled, sealed in liquid nitrogen, and then stored in the 4°C refrigerator. If possible, gravity cores will also be collect on a transect of the anti-cline.

*Deployment from the starboard A-frame 9/16 and 1/4 wire.*

3. Multi-core
Two multi cores from each Station will be collected and cores distributed for different science party members. One core will be logged and preserved in anoxic conditions. One core will be subsampled and preserved in anoxic conditions. The remaining cores will be analyzed for benthic fauna and micro-fossils.

*Deployment from the stern A-frame 9/16 wire.*

4. Soutar box core
Two souter box cores from each Station will be collected and subsampled for different science party members. Arndt Schimmelmann’s vacuum pump system will sub-sample the core. Four cores will be logged, x-rayed, and preserved in anoxic conditions. Three cores will be subsampled and preserved in anoxic conditions. The remaining material will be analyzed for benthic fauna and micro-fossils.

*Deployment from the stern A-frame 9/16 wire.*

5. Kasten core
Two Kasten cores from each Station will be collected and subsampled for different science party members. Arndt Schimmelmann’s vacuum pump system will sub-sample the core. Four cores will be logged, x-rayed, and preserved in anoxic conditions. Three cores will be subsampled and preserved in anoxic conditions. The remaining material will be analyzed for benthic fauna and micro-fossils.

*Deployment from the stern A-frame 9/16 wire.*

6. CTD
Three CTD casts will be taken at each Station. The first cast will create a profile of the water column, releasing two bottles from 10-12 depths (ie. 5m, 20m, 50m, 75m, 125m, 150m, 200m, 250m, 300m, 400m, 450m). The second and third casts will collect bulk samples from 450m and 200m.

*Deployment from the starboard 322 wire.*

7. **IKMT (Isaacs-Kidd Mid-water Trawl)**
   Six IKMT tows will be taken at Station 1. All tows need to be completed in deep water in the Santa Barbara Basin (~500m), at a speed of 2.5 knots through the water (not speed over ground), into (against) the prevailing current. Three of the tows will be deployed to a depth of 150 meters (a shallow tow), and towed at depth for 30 minutes. The other three tows will be deployed to a depth between 450 and 500 meters (where possible), and towed at depth for 30 minutes. All samples must be collected and aboard at minimum 2 hours after sunset and 2 hours before dawn. Materials will be distributed for preservation in formalin and isopropyl alcohol and DNA extraction and isotopic/lipid analyses in ethanol.

*Deployment from the stern A-frame 9/16 wire.*

8. **1 m² MOCNESS; 202 µm mesh size**
   Each tow will be deployed to the deepest depth possible at each station (~500m). All samples must be collected and aboard at minimum 2 hours after sunset and 2 hours before dawn. The net will be towed at an oblique angle (41°) at a speed of 2.0 knots through the water (not speed over ground), into (against) the prevailing current. Each of the nine nets will be opened and sampling for 15 minutes at the depths: 500-400m, 400-350m, 300-250m, 250-200m, 200-150m, 150-100m, 100-50m, and 50-0m. Materials will be distributed for preservation in formalin and isopropyl alcohol and DNA extraction and isotopic/lipid analyses in ethanol.

*Deployment from the starboard 322 wire.*

   *Attachments: CTD, Fluorometer, DO sensor, Transmissometer, Flowmeter*

9. **Water filter**
   16 hours of filtering for lipids for periods of 4.5 hours will occur at both Stations. Filters will be stored in the 4°C refrigerator after collection.

*Deployment from the starboard 1/4 wire.*

10. **Acoustics frame**
    Acoustic profiles will be taken at Station 1 immediately before or after the MOCNESS tows. A broadband high frequency acoustic instrument developed by Jules Jaffe will be utilized to obtain acoustic estimates of plankton-size particles. The platform used, MAZOOPS, will be deployed in a self-contained mode, and does not require wiring or syncing to deck systems. The frame and instrument weighs 180lbs.

*Deployment from the starboard 1/4 wire.*

11. **Bongo and/or plankton net**
    The bongo and other plankton nets will be deployed opportunistically as time allows.

*Deployment from the starboard 1/4 wire.*
III. Research Requests

Station 1: Anoxic zone (26 September – 30 September)

Goals:
1. Laminated sediment record to last glacial (around 20m).
2. High resolution laminated sediment record of past 2000 years.
4. Water sampling and profile.
5. Mesopelagic fish and zooplankton population characterization.

Primary requests:

3 piston cores Summers, Vavrek, Fissel, Jones
8 gravity cores Summers, Vavrek, Fissel, Jones, Schimmelmann, Briseno,
2 box cores Schimmelmann, Fissel, Jones, Summers, Briseno
2 multi-cores Summers, Schimmelmann, Fissel, Jones, Vavrek, Briseno

6 night IKMT (3 shallow, 3 deep) Bowlin, Powell, Ugalde, Summers
4 night MOCNESS Bowlin, Powell, Ugalde, Briseno, Summers
2 day MOCNESS Briseno, Summers
6 acoustic frame Briseno

3 CTD (one profile, two for bulk water) Kharbush, Summers, Ugalde, Briseno
16 hours water filtering Kharbush
Night squid jigging Martin

Secondary requests:

1 Kasten core Schimmelmann
8 hours water filtering Kharbush
2 night MOCNESS Bowlin, Powell, Ugalde, Briseno, Summers
Night bongo Powell
1 CTD (profile) Kharbush, Summers, Ugalde, Briseno
1 box core Schimmelmann, Fissel, Jones, Summers, Briseno
1 multi-core Summers, Schimmelmann, Fissel, Jones, Vavrek
1 day MOCNESS Briseno
1 day acoustic frame Briseno
100um mesh plankton tow Norris
Within Santa Barbara Basin secondary requests:

Goals:
1. Sample longer record back to 1my using a series of gravity cores.
2. Explore benthic and pelagic changes downslope from oxic to anoxic waters.

8 gravity cores/8 box cores on the anti-cline  Vavrek, Summers, Fissel, Jones
1 box core at sill depth  Schimmelmann
1 Kasten core at sill depth  Schimmelmann
Multicore transect in oxic waters  Summers, Sibert

Station 2: ODP 1015 (October 1-2)

2 piston cores  Summers, Vavrek, Fissel, Jones
3 gravity cores  Summers, Vavrek, Fissel, Jones, Briseno
1 multi-core  Summers, Briseno
2 CTD (one profile, one bulk)  Kharbush, Summers
8 hours water filtering  Kharbush
Night squid jigging  Martin
II. Cruise Plan:

Sunrise: 6:50-7:00am
Sunset: 6:50-6:40pm
Bold denotes key times to start sequences of deployment.

September 25
0800 Depart Marfac
0800 – 0200 Travel San Diego to Santa Barbara Basin (18 hours)

September 26

Center of basin
0300 – 0500 IKMT stern-A (9/16)
0500 – 0800 4 gravity cores star-A (9/16)
0800 – 0900 CTD squirt boom (322)
0900 – 1100 Piston deployment star-A (9/16)
1100 – 1300 Water filtering (2 hours) star- (1/4)
1300 – 1500 Multi core stern-A (9/16)
1500 – 1600 CTD star- (322)
1600 – 1800 Multi core stern-A (9/16)
1800 – 2000 Water filtering (2 hours) star- (1/4)
2000 – 2100 Acoustic frame star- (1/4)
2100 – 2400 MOCNESS star- (322)

September 27
2400 – 0200 IKMT stern-A (9/16)
0100 – 0400 MOCNESS squirt boom (322)
0400 – 0500 Acoustic frame star- (1/4)
0500 – 0800 4 gravity cores star-A (9/16)
0800 – 0900 CTD squirt boom (322)
0900 – 1100 Piston deployment star-A (9/16)
1100 – 1300 Water filtering (2 hours) star- (1/4)
1300 – 1400 Piston deployment star-A (9/16)
1400 – 1500 CTD squirt boom (322)
1500 – 1700 Box core star-A (9/16)
1700 – 2000 Water filtering (2 hours) star- (1/4)
2000 – 2100 Acoustic frame star-A (9/16)
2100 – 2400 MOCNESS squirt boom (322)

September 28
2400 – 0200 IKMT stern-A (9/16)
0100 – 0400 MOCNESS squirt boom (322)
0400 – 0500 Acoustic frame star- (1/4)
0500 – 0700 Box core star-A (9/16)
0700 – 0800  Water filtering (1 hours)  star- (1/4)
0800 – 0900  Acoustic frame  star-A (9/16)
0900 – 1200  MOCNESS (day)  squirt boom (322)
1200 – 1400  Box core  star-A (9/16)
1400 – 1700  MOCNESS (day)  squirt boom (322)
1700 – 1800  Acoustic frame  star-A (9/16)
1800 – 1900  Kasten core  stern-A (9/16)
1900 – 2100  Water filtering (1 hours)  star- (1/4)
2100 – 2300  IKMT  squirt boom (1/4)
2300 – 0200  MOCNESS  squirt boom (322)

September 29

0200 – 0400  IKMT  stern-A (9/16)
0400 – 0500  Bongo net  squirt boom (1/4)
0500 – 0700  Kasten core  stern-A (9/16)
0700 – 1100  Water filtering (4 hours)  star- (1/4)

Secondary Science: opportunistic transect of anti-cline and sampling at sill depth
Revolution of 3 gravity cores
1 box core

1700 – 2100  Water filtering (4 hours)  star- (1/4)
2100 – 2300  IKMT  squirt boom (1/4)
2300 – 0200  MOCNESS  squirt boom (322)

September 30

0200 – 0400  IKMT  stern-A (9/16)
0700 – 1100  Water filtering (4 hours)  star- (1/4)

Secondary Science: opportunistic transect from oxic to anoxic at mid-basin and along ridge
Revolution of box cores
Plankton net

1700 – 2100  Water filtering (4 hours)  star- (1/4)
2000 – 2100  Acoustic frame  star- (1/4)
2100 – 2400  MOCNESS  squirt boom (322)

October 1

2400 – 0200  IKMT  stern-A (9/16)
0100 – 0400  MOCNESS  squirt boom (322)
0400 – 1000  travel

Outside anoxic zone:
1000 – 1300  4 gravity cores  star-A (9/16)
1300 – 1400  CTD  squirt boom (322)
1400 – 1600  Piston deployment  star-A (9/16)
1600 – 1800  Water filtering (2 hours)  star- (1/4)
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
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<tbody>
<tr>
<td>1800 – 2000</td>
<td>Multi core</td>
<td>stern-A (9/16)</td>
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<tr>
<td>2000 – 2100</td>
<td>CTD</td>
<td>star- (322)</td>
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<tr>
<td>2100 – 2300</td>
<td>Multi core</td>
<td>stern-A (9/16)</td>
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**October 2**

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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>2300 – 0100</td>
<td>Water filtering (2 hours)</td>
<td>star- (1/4)</td>
</tr>
<tr>
<td>0100 – 0400</td>
<td>4 gravity cores</td>
<td>star-A (9/16)</td>
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<tr>
<td>0400 – 0600</td>
<td>Water filtering (2 hours)</td>
<td>star- (1/4)</td>
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<td>0600 – 0800</td>
<td>Piston deployment</td>
<td>star-A (9/16)</td>
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<tr>
<td>0800 – 1000</td>
<td>Water filtering (2 hours)</td>
<td>star- (1/4)</td>
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<tr>
<td>1000 – 1200</td>
<td>Piston deployment</td>
<td>star-A (9/16)</td>
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<tr>
<td>1200 – 1300</td>
<td>CTD</td>
<td>squirt boom (322)</td>
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<td>1300 – 1500</td>
<td>Box core</td>
<td>star-A (9/16)</td>
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<tr>
<td>1500 – 1700</td>
<td>Water filtering (2 hours)</td>
<td>star- (1/4)</td>
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<tr>
<td>1700 – 1900</td>
<td>Box core</td>
<td>star-A (9/16)</td>
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<td>1900 – 2100</td>
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<td>star- (1/4)</td>
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<td>2100 – 0400</td>
<td>Secondary science: opportunistic</td>
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**October 3**

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<th>Time</th>
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<tbody>
<tr>
<td>0400-1600</td>
<td>Travel Santa Barbara Basin to San Diego (12 hours)</td>
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<tr>
<td>1600</td>
<td>Return Marfac</td>
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### V. Berths

| Science Party | 1 | Mindi Summers |
|               | 2 | Christian Briseno |
|               | 3 | Ben Fissel |
|               | 4 | Jenan Kharbush |
|               | 5 | Summer Martin |
|               | 6 | Juan Ugalde |
|               | 7 | Jesse Vavrek |
|               | 8 | Bill Jones |
|               | 9 | Jesse Powell |
|               | 10 | Noelle Bowlin |
|               | 11 | Richard Norris |
|               | 12 | Robert Naviaux |
|               | 13 | Greg Rouse |
|               | 14 | Lihini Aluwihare |
|               | 15 | Arndt Schimmelmann |
|               | 16 | Juergen Schieber |
|               | 17 | OSU Coring |
|               | 18 | OSU Coring Engineer |
|               | 19 | Elizabeth Sibert |
|               | 20 | Dave Griffith |
|               | 21 | Videographer |
|               | 22 | GK12 teacher |
|               | 23 | GK12 teacher |
|               | 24 | GK12 student |
|               | 25 | GK12 student |
|               | 26 | Berea HS |
|               | 27 | Berea HS |
|               | 28 | Residential Tech |
|               | 29 | Residential Tech |
|               | 30 | Residential Tech |
|               | 31 | Residential Tech |
|               | 32 | Residential Tech |
|               | 33 | Residential Tech |
|               | 34 | Residential Tech |
|               | 35 | Residential Tech |
|               | 36 | Residential Tech |
|               | 37 | Residential Tech |
|               | 38 | Computer Tech |