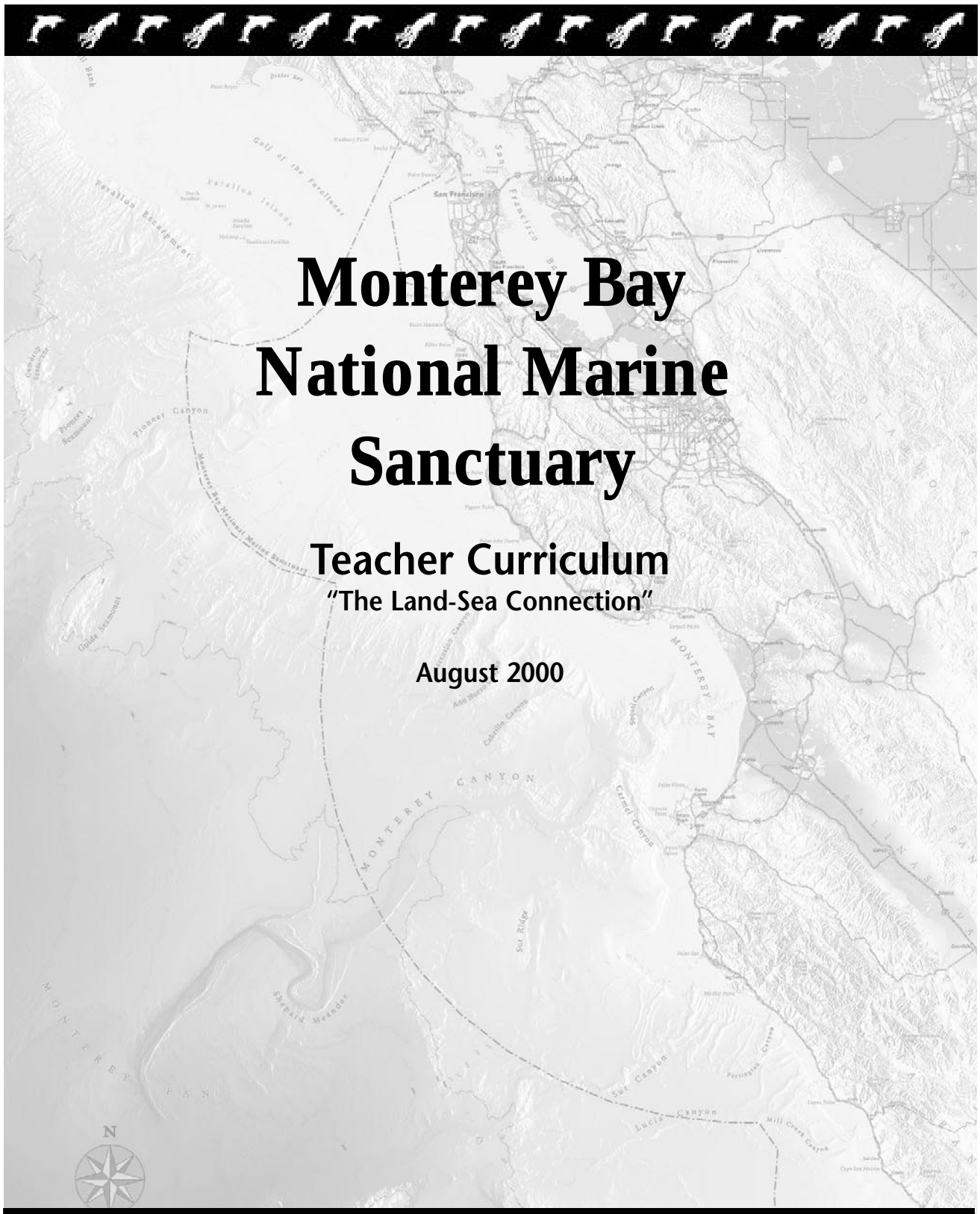

Monterey Bay National Marine Sanctuary

Teacher Curriculum

"The Land-Sea Connection"

August 2000

Sustainable Seas Expeditions

Monterey Bay National Marine Sanctuaries

National Geographic Society

August 2000

Dear Educator:

The teacher curriculum "**The Land-Sea Connection**" was developed to complement a full-color, bathymetric & topographic map of the Monterey Bay National Marine Sanctuary. This curriculum will increase your students understanding of science and geography, and also introduce them to the excitement of real-time underwater exploration. We invite you and your students to join the *Sustainable Seas Expeditions*, a deep sea research mission, via the Internet, discuss marine policy and management in the classroom, and conduct a monitoring transect within the Monterey Bay National Marine Sanctuary.

Some of the content included in this guide was adapted from the 1999 Sustainable Seas Expeditions Teacher Resource Book. We highly recommend use of the SSE Teacher Resource Book as it contains many more ideas and activities for enriching and supplementing your science curriculum. The guide is available at website: www.sanctuaries.nos.noaa.gov/special/special.html#TeacherBook

Curriculum learning objectives include

- using a topographic map as a tool for recognizing geophysical features of the Monterey Bay National Marine Sanctuary, and its biological and cultural resources
- exploring the connection between our land-based actions and the health of the oceans
- being introduced to the concept and technology of Geographic Information Systems (GIS), and the use of geographic overlays to answer spatial questions.

Highlights of the state-of-the-art map include

- special characteristics of seafloor bathymetry and land topography
- coastal watershed features that connect to the Sanctuary
- never-before-seen features of the Monterey Canyon
- urban development and agricultural areas
- cities & roads, mountains & valleys, seamounts & canyons

To request a printed copy of the map and curriculum, in either English or Spanish, please contact Karen Grimmer at (831) 647-4201 or karen.grimmer@noaa.gov. Both html and pdf versions are now available on the web at www.bonita.mbnms.nos.noaa.gov/Educate/teachercurriculum/index.htm

We welcome your comments, suggestions and feedback via the included evaluation, by email, or by phone. On August 16, 2000, a group of teachers and marine educators met to evaluate and revise this draft guide, and share their ideas for additional activities. We hope to build upon those ideas, and produce a final and more expansive edition of this curriculum.

The largest and deepest of the marine sanctuaries, Monterey Bay, spans more than 5,300 square miles of wave-swept beaches, lush kelp forests, and steep canyons filled with life ranging from tiny plants to huge blue whales. We hope the new map and curriculum will help your students increase their understanding of the extraordinary environment and resources of the Monterey Bay National Marine Sanctuary. More information may be found at www.bonita.mbnms.nos.noaa.gov

Best wishes,
Education Staff

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These materials were designed for grades 7–12 but may be adapted for other grade levels.

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Printed in the United States of America.

Printed on recycled paper.

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Acknowledgments

We would like to thank all those who have dedicated their lives to the protection and preservation of this ocean planet.

Produced with support from Duke Energy.

Photos:

Nudibranch, Kip Evans
Humpback mother & calf, Dave Mantilla
Purple sea urchin, Laura Francis

NOAA's National Marine Sanctuaries

"Today, marine sanctuaries are places in the sea, as elusive as a sea breeze, as tangible as a singing whale. They are beautiful, or priceless, or rare bargains, or long-term assets, or fun, or all of these and more. Above all, sanctuaries are now and with care will continue to be 'special places.' Each of us can have the pleasure of defining what that means."

—Dr. Sylvia Earle

WHAT ARE MARINE SANCTUARIES?

In 1972, as Americans became more aware of the intrinsic ecological and cultural value of our coastal waters, Congress passed the Marine Protection, Research and Sanctuaries Act. This law authorizes the Secretary of Commerce to designate our most cherished marine waters as national marine sanctuaries, in order to protect and manage their priceless resources. In the years since that time, 13 national marine sanctuaries have been created. They include nearshore coral reefs and open oceans, rich banks and submarine canyons, intertidal areas, and sheltered bays. National marine sanctuaries range in size from less than a neighborhood (Fagatele Bay, American Samoa—0.6 square kilometers or 0.25 square miles) to larger than the state of Connecticut (Monterey Bay—13,800 square kilometers or 5,328 square miles).

Sanctuaries harbor a dazzling array of algae, plants, and animals. These protected waters provide a secure habitat for species close to extinction; and they protect historically significant shipwrecks and archaeological sites. They serve as natural classrooms for students of all ages and as living laboratories for scientists.

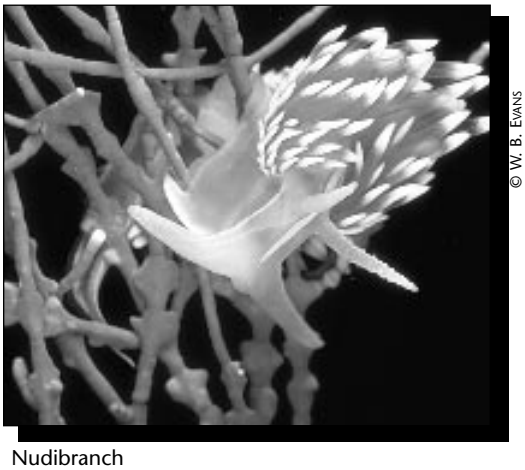
NOAA's National Marine Sanctuaries

Sanctuaries are cherished recreational spots for diving, wilderness hiking, and sport-fishing. They also support valuable commercial industries such as marine transportation, fishing, and kelp harvesting. The perpetual challenge of managing these areas is maintaining the critical balance between environmental protection and economic growth.

SANCTUARIES FOR ALL

A sanctuary's true definition lies in the eyes of the beholder. To a scientist, a sanctuary is a natural laboratory. To a motel owner it is an attraction to visitors. To schoolchildren, a sanctuary is a special playground—a place to explore and discover. To environmental engineers charged with restoring damaged ecosystems, a sanctuary is a yardstick against which they can gauge "good health." Fishermen, however, might see the sanctuary as a threat to traditional freedoms, yet upon reflection, realize that it is the best hope for maintaining their way of life.
Trying to meet these needs leaves many unanswered questions. How large does a sanctuary need to be in order to protect the ecosystems that lie within? How much pressure can an ecosystem sustain from activities bordering its boundaries? How many fish can we take while ensuring a healthy population for the long term?

National marine sanctuaries represent our riches as a nation. They are treasures that belong to every citizen, and to every generation of citizens to come. We have the right to enjoy them and—just as importantly—the responsibility to sustain them for the long-term.



Nudibranch

SANCTUARY MANAGEMENT

Responsibility for the entire National Marine Sanctuary program lies within the National Oceanic and Atmospheric Administration (NOAA), which is under the US Department of Commerce.

On a local level, the Monterey Bay National Marine Sanctuary Advisory Council was established by Federal law to assure continued public participation in the management of the Sanctuary. Since its establishment in March 1994, the Council has played a vital role in the decisions affecting the Sanctuary along the central California Coast. The Council's nineteen voting members represent a variety of local user groups, as well as the general public, plus seven local, state and federal governmental jurisdictions. In addition, the respective managers for the four California National Marine Sanctuaries (Channel Islands National Marine Sanctuary, Cordell Bank National Marine Sanctuary, Gulf of the Farallones National Marine Sanctuary, and the Monterey Bay National Marine Sanctuary) and the Elkhorn Slough National Estuarine Research Reserve sit as non-voting members.

Dedicated Council members have laid a strong foundation for the Sanctuary's structure, policies, and procedures. Sanctuary goals to promote research, education and resource protection are a major focus for the Council, and members work diligently to promote public stewardship.

The Council has proven to be a powerful voice for the general public, responding to citizen concerns, ideas and needs. The Council provides a public forum for its constituents, working to enhance communications and provide a conduit for bringing the concerns of user groups and stakeholders to the attention of Sanctuary managers and the National Oceanic and Atmospheric Administration Headquarters in Washington, D.C.

Ecosystem Monitoring in the Sanctuaries

Putting monitoring research into perspective requires understanding three important goals of the research projects:

- Understanding what is there by systematic exploration, mapping, and species inventories—a process known as site characterization;
- Looking at a place over time and making spatial comparisons to understand what changes are taking place, and why—a process known as monitoring;
- Assessing the potential of new tools, like the DeepWorker underwater submersible, in research and management of marine sanctuaries.

SITE CHARACTERIZATION

In order to understand any natural environment and make wise decisions that lead to its protection, sanctuary managers need several critical pieces of information. These include knowing what is there (the "parts" of an ecosystem such as the algae, plants, animals, water temperature, and so on), the ecosystem's condition in the past—or at least its condition now—and enough understanding of how the ecosystem works to predict future conditions given certain variables. These are all elements of what sanctuary managers call "site characterizations." Check out MBNMS's site characterization at http://bonita.mbnms.nos.noaa.gov/sitechar/main.html

Site characterizations provide managers with information that helps them make effective decisions when it comes to determining human activities in protected areas; setting agendas for research, monitoring, education, outreach, and enforcement programs; and using the most appropriate methods to restore an area, should that be necessary.

Site characterizations are detailed reports that contain information on an area's biological and physical environments, cultural history, and human use patterns. They chronicle the history of discovery and use, the record of scientific investigations, the pressures being placed on natural and cultural resources, and the nature of attempts to protect the resources. Properly done, they are complete sources of current information for an area of particular interest.

When conducting site characterizations, there are a number of ways scientists document the presence and abundance of species relative to the environment's physical factors. One method is conducting vertical and horizontal transects.

Vertical transects in the sea are useful to define the ocean's layering system of physical and biological parts. Imagine dropping a line from one point in the water column down to another. Physical factors are then observed and recorded at various points along this line, or transect. Increments along the transect are usually evenly spaced, and when combined with similar transects in other locations, may reveal changes taking place due to water currents, upwelling, and other phenomena.

Horizontal transects are conducted similarly. These are most often used along the seafloor or at a particular depth. For instance, a horizontal transect at a depth of 600 meters might look for distribution of fish species close to a canyon wall compared to fish species at the same depth further from the wall.

Given the constraints of time and money, these techniques provide researchers with methods to construct models of an ecosystem while only studying small portions of it. The models help us understand how an ecosystem functions. They may describe the flow of energy through a system or they may allow us to predict the effects of natural or human-caused events on an ecosystem.

MONITORING

Monitoring programs are designed to detect changes spatially and over time—changes in physical conditions, changes in distribution or abundance of organisms, or changes caused by human actions and natural events.

Physical factors such as temperature and salinity measured as baseline data can form the foundation of a monitoring program. So can the presence or absence of a species, or age groups of a single species or entire groups of species. Habitats can be monitored to observe changes in structure, such as physical disturbance. In a monitoring project, observations are made or samples are taken—like "snapshots" of the habitat—on a regular basis, at various intervals depending on the type of information needed. Periodic reports of data compare snapshots against each other and against the baseline data. This information helps resource managers evaluate trends (systematic changes over time) or perturbations (sudden changes). Although the causes of these changes may not be apparent as a result of monitoring, they alert managers and suggest ways of studying, in closer detail, the causes of change.

Geographic Information System (GIS) is a powerful new tool that allows resource managers to get a "visual" representation, overtime, of how resources relate to each other, and to humans. Here is a *hypothetical* example of how GIS can be utilized. Monitoring data tell us that over the past five years, the number of coastal recreational areas has increased. During that same period, there was a reduction in the number of active seabird nesting sites. This became apparent when looking at the same two GIS overlays in 1995 and then again in 2000. One might infer that the increased human activity is disturbing the seabirds as they nest. In an actual example, sanctuary researchers would closely assess the situation, and if needed, recommend further regulations. The first activity in this guide will also demonstrate the power of this new cutting edge tool known as GIS. For more information: http://sustainableseas.noaa.gov/missions/channel2/background/gis.html

ASSESSING RESEARCH TOOLS

National Geographic and the National Oceanic and Atmospheric Administration have recently launched a deep sea exploration called "Sustainable Seas Expeditions." In addition to supporting sanctuary site characterization and monitoring needs, the five-year *Sustainable Seas Expeditions* project and the newly developed submersible technology offer the scientific community a chance to evaluate the use of the new one-person sub. Nuytco Research Ltd. developed the lightweight DeepWorker submersible (900 kilograms, or 2,000 pounds) to operate almost as easily as remotely operated vehicles (ROVs), which are unmanned, underwater robots often used at these depths. With the potential of new discoveries beckoning and a new national commitment to assess and understand our ocean planet, the *Sustainable Seas Expeditions* promise new knowledge and new ways to gather knowledge over the next five years. For more information check out the SSE website: http://sustainableseas.noaa.gov & theNational Geographic website: http://www.nationalgeographic.com/seas/ax/fs/section_fs.html?equipment:deepworker

Deepwater jelly

KEVIN RASKOFF © MBARI 1998

Meet DeepWorker

AN OCEAN EXPLORER'S DREAM

DeepWorker 2000 is a one-person submersible about the size of a small car. This remarkable vehicle can dive to a depth of 600 meters (2,000 feet) and provide life-sustaining oxygen for its pilot for up to 100 hours (in an emergency—normal operations rarely exceed 12 hours). Without tethers or connecting lines to its support ship, DeepWorker gives its pilot amazing mobility and the gift of time—a precious commodity for humans in the underwater environment.

Because DeepWorker is a directly operated vehicle—or DOV—it moves independently of its surface support ship. The sub is driven by a trained pilot who may be a scientist, a technician, an explorer, or even a journalist, teacher, or poet. The sub's simple, yet sophisticated technology means that the pilot and the passenger are combined—one person can pilot the craft and still carry out observations and scientific experiments. Eliminating the second occupant from the sub reduces its weight, complexity, and the expense of operation.

DEEPWORKER'S TOOLS

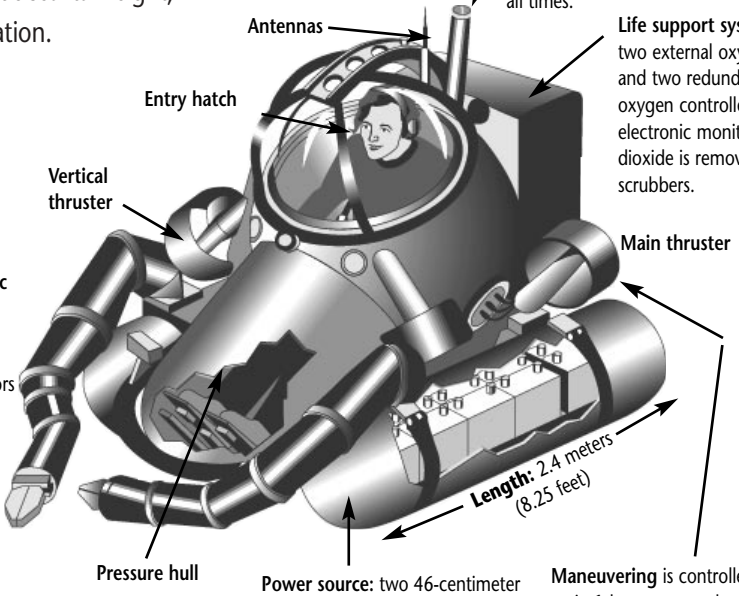
In addition to DeepWorker's design and life support systems, the sub also uses specialized equipment to document marine life, habitat characteristics, and to monitor physical factors such as temperature, the amount of light penetrating the sea, and water quality. Equipment for collecting this data includes:

- cameras (video and still);
- external lights that can be turned on and off;
- a CTD instrument that continuously records conductivity (to determine salinity), temperature, and depth;
- manipulator arms capable of reaching to 3.6 meters (12 feet);
- cable cutters on the arms to cut free from entanglement;
- suction samplers to collect sea water and animals;
- ocean floor core samplers; and
- sample baskets for transporting organisms.

DeepWorker 2000

SPECIFICATIONS
Weight in air: 1,300 kilograms (1.3 tons)
Operating depth: 600 meters (2,000 feet)
Payload: 114 kilograms (250 pounds), including pilot
Life Support: 100 hours
Speed: 3 knots
Crew: 1 pilot

COMMUNICATION SYSTEMS include a modified Imaginex sonar, which allows standard scanning and ultra-high resolution for short range. Ocean sounds are recorded with a directional hydrophone. Video cameras allow the pilot to record the dive. VHF and thru-water communications allow contact with surface support personnel.



.For more information on Deepworker see:
http://sustainableseas.noaa.gov/aboutsse/technology/equipment/deepworker.html

Humpback mother and calf © Dave Matilla

INVESTIGATION 1

How would an oil spill affect a Marine Sanctuary?

In this investigation, students consider the criteria used to assess damage to natural resources and mitagation measures when a large scale environmental threat, such as an oil spill, occurs.

BACKGROUND INFORMATION

NOAA's National Marine Sanctuaries

ACTIVITY

Danger - Oil Spill in the Sanctuary!

LEARNING OBJECTIVES

Students will:

- Learn what the terms resources and stakeholders mean;
- Investigate how a human impact, in this case an oil spill, can affect Sanctuary resources;
- Communicate, in a mock public meeting, how to most effectively mobilize people and resources to protect the Sanctuary;
- Be introduced to Geographic Information System technology.

STANDARDS

Geography Standard 3
How to analyze spatial organization of people, places, and environments on the Earth's surface

Geography Standard 18
How to apply geography to interpret the present and plan for the future

Science Education Standards
Developing self-directed learners

How to read and interpret graphic and geologic maps

ACTIVITY

Danger - Oil Spill in the Sanctuary!

Guiding Question

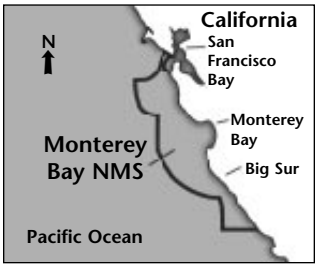
What Sanctuary resources might be affected in the advent of a large-scale oil spill?

Materials

- ❑ **NOAA's National Marine Sanctuaries** for each student group (see Teacher Resource book volume 1)
- ❑ **Oil Spill Activity Cards**, one set for each student group
- ❑ **Oil Spill Scenario & Presentation Guidelines,** one set for each student group
- ❑ **Monterey Bay National Marine Sanctuary (MBNMS) Map**, one for each student group
- ❑ **GIS Overlays***, one set for each student group
- ❑ Overhead Projector and transparency markers for presentations
- ❑ Access to the Internet (optional)
- ❑ Paper for student journals or lab notebook.
- ❑ Full-sized color poster of MBNMS, available from the MBNMS office. Contact Karen Grimmer; karen.grimmer@noaa.gov, (831) 647-4201

** Prepare overlays by photocopying masters onto transparencies.*

Discussion



What Makes Monterey Bay National Marine Sanctuary Special? Monterey Bay, the largest of NOAA's marine sanctuaries, hosts a rich array of habitats. Within its boundaries lie rugged rocky shores, lush kelp forests, and one of the deepest underwater canyons on the west coast. The canyon cuts more than 3,500 meters (2 miles) deep and reaches nearly 100 kilometers (60 miles) out to sea. Sanctuary habitats abound with life, from tiny plankton to huge blue whales. With its great diversity of habitats and life, the sanctuary is a national focus for marine research and education program.

Habitats

Sandy beaches	Submarine canyon
Rocky shores	Pelagic, open ocean
Kelp forests	Wetlands

Key Species

Sea otter	Brown pelican
Gray whale	Rockfish
Market squid	Giant kelp

Cultural Resources

Indian midden sites
Naval airship USS Macon

Latitude and Longitude: 36° N 122° W
Web Site Address:
http://www.mbnms.nos.noaa.gov

Procedure:

Part 1: What is a Marine Sanctuary?

1 On the board or overhead projector, write the words "marine sanctuary." Tell students that 13 national marine sanctuaries have been set aside in the United States since 1972.

2 Using the **National Marine Sanctuaries** Background Information sheet as a guide, describe to your students why marine sanctuaries were established and how they are managed. Start them thinking about what marine sanctuaries are—establishing what they already know and encouraging them to ask and answer their own questions about sanctuaries and the marine environment.

3 Discuss with students the role of national parks, both on land and at sea, as special places that preserve algae, plants, and animals, the habitats in which they live, unique landforms, and recreational opportunities for people. Compare the establishment of the first national park, Yellowstone, in 1872 to the establishment of the first national marine sanctuary, the sunken ship *Monitor,* about one hundred years later.

Part 2: Using the MBNMS Map for an Investigation

1 Using the poster-size MBNMS Map, as a class, look at the scale and color bars in the bottom left corner. Identify which colors are urban areas (gray), ocean (light & dark blue depending on depth), low-lying croplands and coastal wetlands (green).

2 Identify some of the dominant features of the map. These might include Monterey Bay, the city nearest your school, the mountain ranges (Santa Lucia, Gabilan, Santa Cruz, & Diablo Range), the undersea canyons (Soquel, Carmel, & Monterey), rivers leading to the Sanctuary (Salinas, Pajaro, & San Lorenzo), and Highway 1 and 101.

3 Discuss the use of Geographic Information System (GIS) as a technological tool for creating maps and analyzing areas spatially. Using an overhead projector and transparency copies of GIS overlay sheets, briefly look at the different types of data that scientists have collected. For More GISinformation see: http://sustainableseas.noaa.gov/missions/channel2/background/gis.html

4 Explain that these images are created from distinct GPS (Geographic Positioning System) data points that are input into a computer in units of longitude and latitude.

5 Lay the GIS transparencies on top of each other to demonstrate how GIS data is considered multi-dimensional or spatial. These overlays will be the informational sources that students will use during their mock public meeting presentations.

6 Discuss the importance of monitoring natural areas in order to identify if changes are due to natural or human disturbances. Please refer to *"Ecosystem Monitoring in the Sanctuaries" (pages 3-4).*

Part 3: What Resources Might be Affected by a Major Oil Spill?

Students will represent six different community groups. (See **Oil Spill Activity Cards**.)
The groups are:
1) the **Sanctuary Advisory Council**, who will preside over a public meeting. See inset "NOAA Announces $50,000 Grant!"
2) US Coast Guard Officers, who will report on the situation as they see it.
3) Park Rangers and Oil Spill Volunteers
4) Scientists
5) Fishing Industry Representatives
6) Monterey Bay National Marine Sanctuary Representatives
The last four groups will present their perspective to the Council on how to mitigate (or reduce) the negative environmental and economic impacts that might occur due to the oil spill event.
*** IMPORTANT NOTE!** There is a grant of $50,000 that will be allocated to the community for dealing with the oil spill's impact.

1 Divide the class into six groups. Each group should receive one of the six **Activity Cards**, an **Oil Spill Scenario** sheet, and a **Presentation Guidelines** card. The cards will explain each group's roles and responsibilities.

2 Read the NOAA $50,000 Grant Announcement (see following page) to the class. Have each group discuss the concerns and answer the questions raised on its activity card.

3 Have each group give a five minute presentation to the Sanctuary Advisory Council following the rules listed in the **Presentation Guidelines** handout.

NOAA ANNOUNCES $50,000 GRANT!

In response to today's environmental disaster - when 300 million liters of crude oil spilled in the Monterey Bay Sanctuary - the National Oceanic & Atmospheric Administration has directed $50,000 toward emergency aid.

At 7:00 pm tonight there will be an emergency public meeting at the town hall, to consider where the funding will go and what actions the public can take to protect our coast and resources.

In order to have a voice in how the funding is allocated, present your case to the Monterey Bay Sanctuary Advisory Council, and they will make the appropriate recommendations to NOAA.

If interested in speaking, please prepare a 5 minute presentation with supporting graphics. You may sign-up upon entry to the meeting. At the close of the meeting, the Council will announce any relevant actions and their funding recommendations.

Please Join in this important effort!

OIL SPILL ACTIVITY CARDS (ONE SMALL CARD PER GROUP)

Panel
SANCTUARY ADVISORY COUNCIL

Primary Concern: Which community groups need funding? How much? Members of this panel may include a state park official, a government official, a scientist, an educator, a business owner, a fishermen, and a diver.

Panel's Task: Listen objectively to all perspectives and recommend to NOAA how the $50,000 should be allocated. You will deliberate after hearing all presentations, and then announce your decisions.

Oil Spill Response Team
U.S. COAST GUARD

Primary concern: Assess the situation and inform the public of the oil spill location, size, direction of movement, potential for damage, etc.

Answer the Questions: What area will be most immediately affected? (plot latitude & longitude) Refer to the Oil Spill Scenario sheet.

Stakeholder Group #1
PARK RANGERS & OIL SPILL VOLUNTEERS

Primary Concern: Impact of the oil spill on wildlife and sensitive habitats.

Answer the Questions: How might the spill affect marine animals and their habitat?

How much of the money, if any, should be put toward rescue and rehabilitation efforts?

Stakeholder Group #2
SCIENTISTS (US Fish & Wildlife biologists)

Primary Concern: Longterm assessment of the oil spill impact on wildlife & natural areas.

Answer the Questions: How long will the environmental impacts of the spill be felt? How would a longterm monitoring study assess this? What types of monitoring techniques are recommended? (Surveys have varied costs depending if they are on foot, by boat or aerial).

Stakeholder Group #3
FISHING INDUSTRY (fishermen, seafood packers & seafood markets)

Primary Concern: Impact of oil spill on fishing

Answer the Questions: How might the oil spill affect fishing, both presently & in the future?

How much money might they lose?

Can they seek reimbursement from the government?

Stakeholder Group #4
SANCTUARY STAFF (resource managers, researchers & educators)

Primary Concern: Impact of oil spill on ***all*** Sanctuary resources. MBNMS is a multi-use area.

Answer the Questions: How can the MBNMS help coordinate all the oil spill clean-up operations? How can the MBNMS support research and monitoring efforts?

OIL SPILL SCENARIO (ONE CARD PER GROUP)

"On January 9th, 2000, a 350 meter cargo freighter _____ (your school name),was traveling in a dense fog, gale winds and heavy seas. At 9:00 pm, the freighter collided with an oil tanker called _____ (another school) which was carrying 300 million liters of crude oil. The bow of the freighter was slightly damaged, but was in no risk of sinking. The oil tanker, however, sustained heavy damage to its midsection. It was leaking oil into the ocean and is in danger of sinking."

The US Coast Guard station in Monterey received a distress signals from both ships and informed the MBNMS of the disaster. Here are the details of the situation.

Tanker Position:	Latitude:	36 degrees 40 minutes north
	Longitude:	123 degrees 10 minutes west
Wind Speed:	35 knots from the NW	
Sea Condition	5 meter waves	
Vessel Damage:	Oil from both the cargo freighter and the tanker was seen on the surface. The oil tanker was definitely sinking. The freighter was dead in the water with engine room flooding and rudder damage.	

PRESENTATION GUIDELINES (ONE CARD PER GROUP)

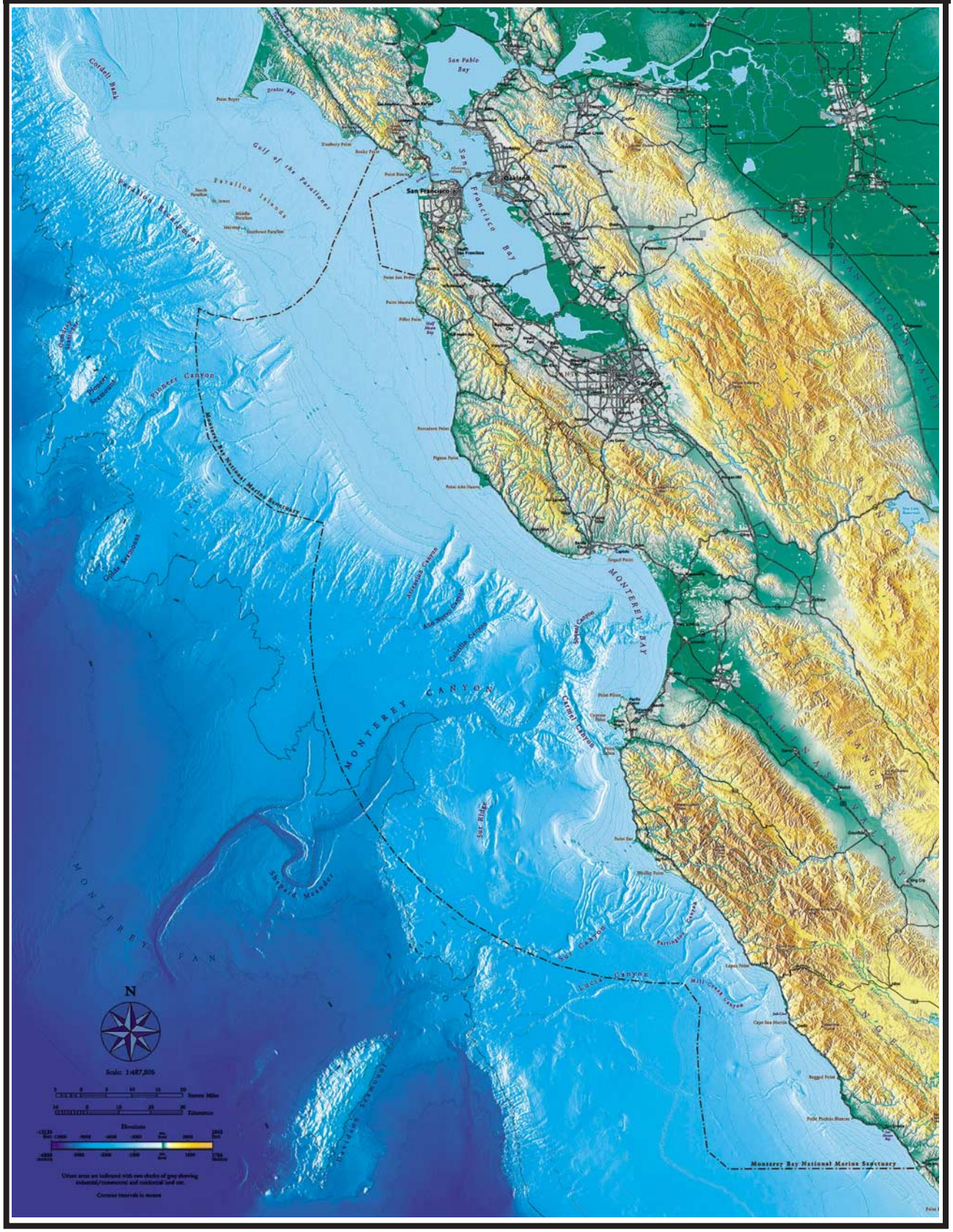
The Sanctuary Advisory Council is composed of 20 federally-appointed representatives from government agencies, local institutions, and user groups (diving, fishing, harbors, agriculture) concerned with the resources of the Monterey Bay National Marine Sanctuary. One student group will represent the council members, and will sit in the front facing the rest of the audience. Their role is to advise NOAA on issues important to the community.

Your stakeholder group must develop and present a clear and persuasive argument to the Council members. You want them to clearly understand what your needs are, and why you deserve a good portion of the $50,000 that is available. The funding is available for clean-up efforts, research and monitoring, and to help mitigate (reduce) the negative effects of the spill.

PRESENTATION RULES

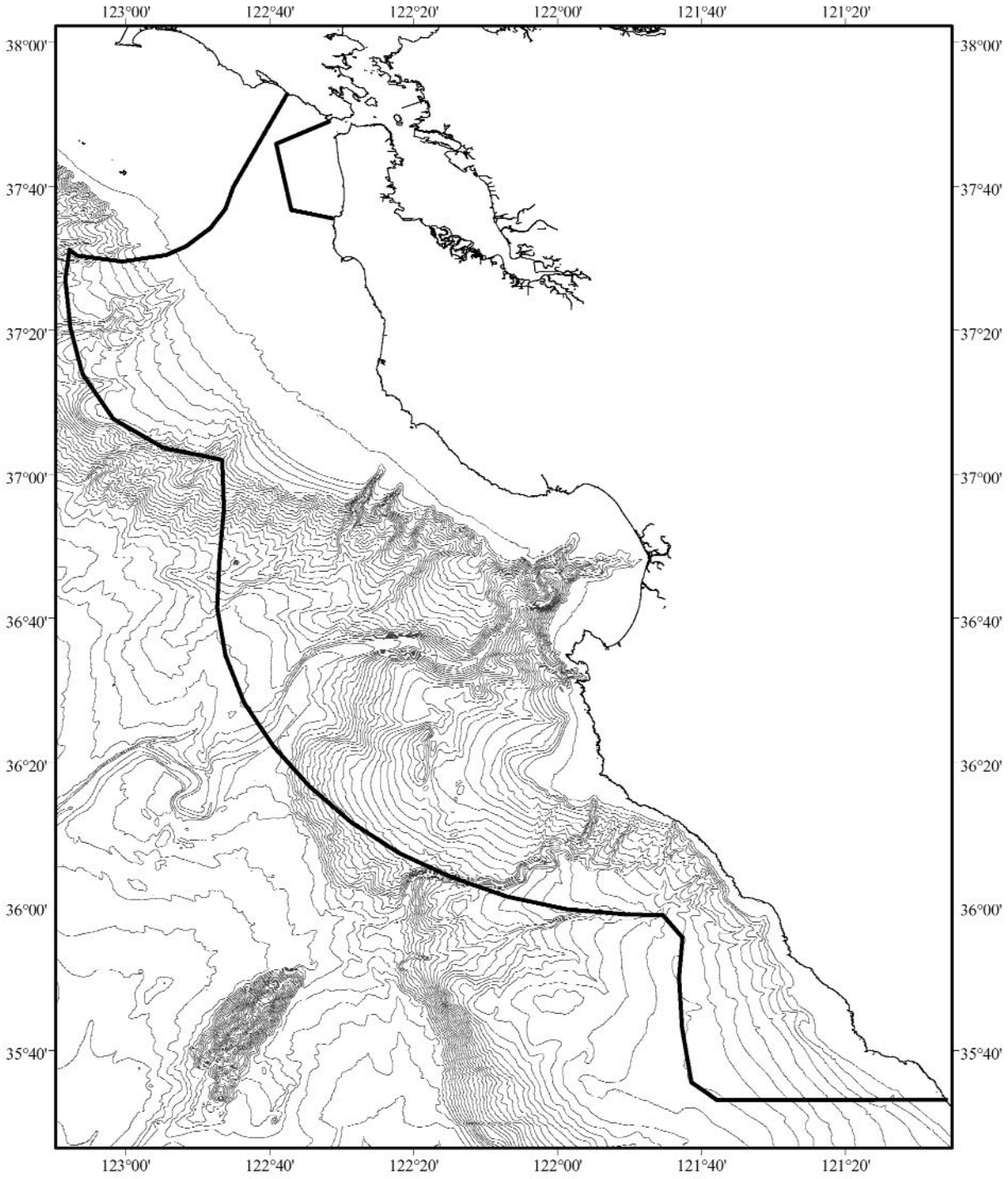
- Each team will have five minutes to present its case to the Sanctuary Advisory Council (SAC).
- Your presentation should be colorful and informative and include the use of color graphics such as the poster-size map and/or GIS overlays with an overhead projector.
- Look through the GIS overlays to find those of importance to your group. Explain why those particular resources are most important to your community group, and how they are or will be affected.
- At the closing of each presentation, there will be five additional minutes allotted for questions and comments from the rest of the audience who have come to participate in this public meeting.
- At the conclusion of all the presentations, the SAC will then deliberate and inform the audience of the recommendations it will provide to NOAA. NOAA will then allocate the funds accordingly.

MAP OF MONTEREY BAY NATIONAL MARINE SANCTUARY



GIS OVERLAY

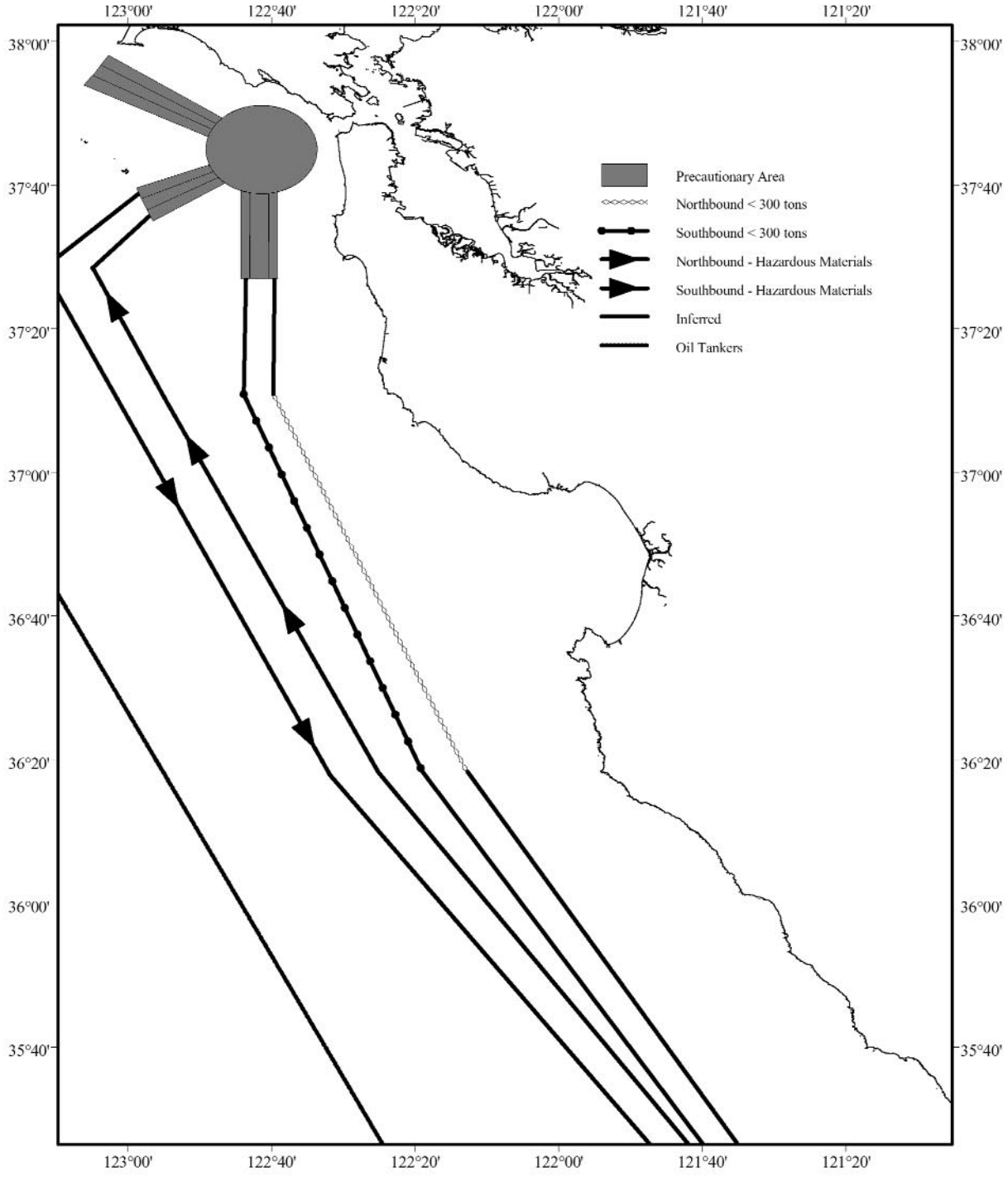
Monterey Bay National Marine Sanctuary
Coastline, Bathymetry (100m intervals), & MBNMS Boundary



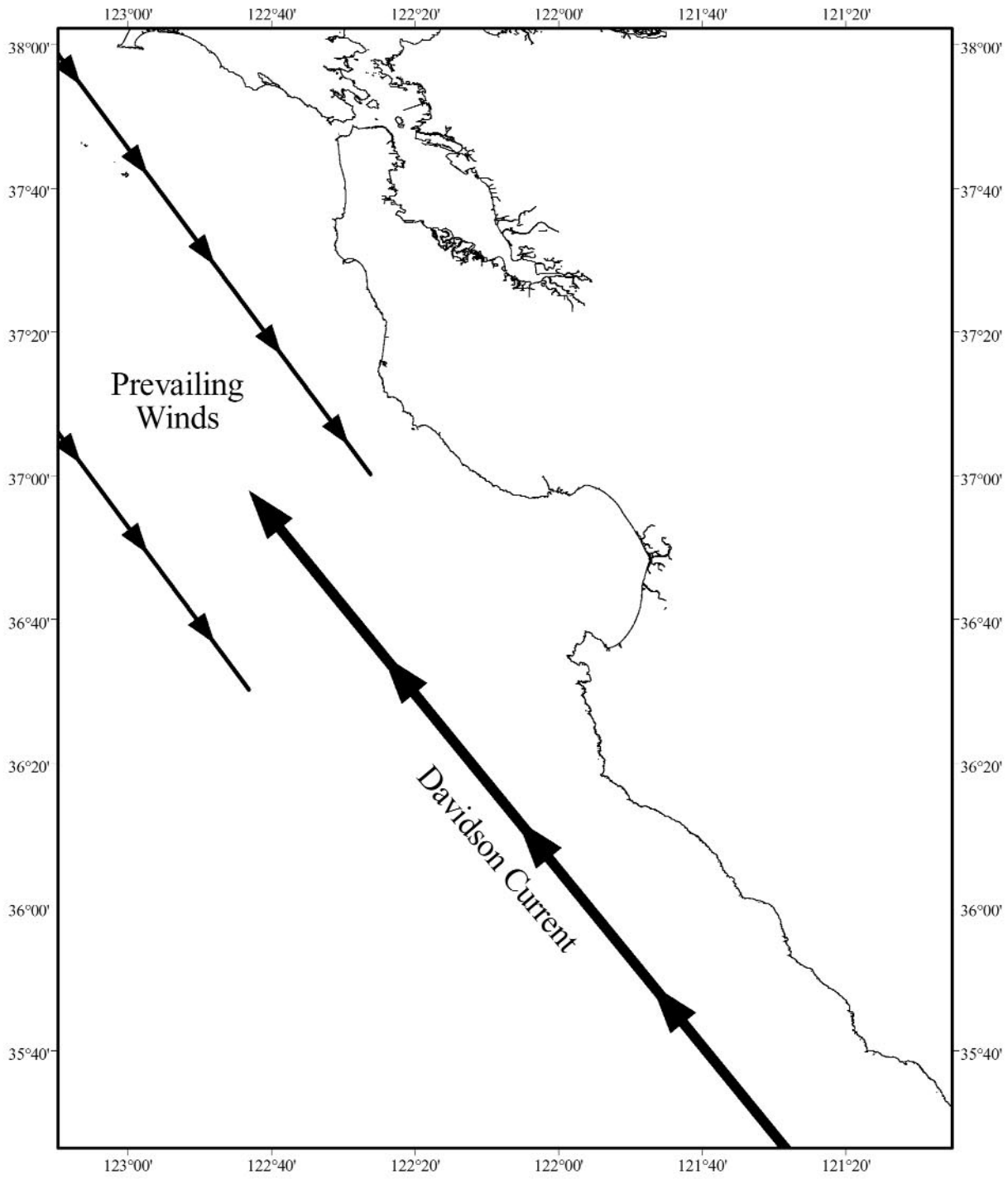
GIS OVERLAY

Monterey Bay National Marine Sanctuary

Vessel Traffic Routes



GIS OVERLAY


Monterey Bay National Marine Sanctuary
Current & Prevailing Winds
123°00'
122°40'
122°20'
122°00'
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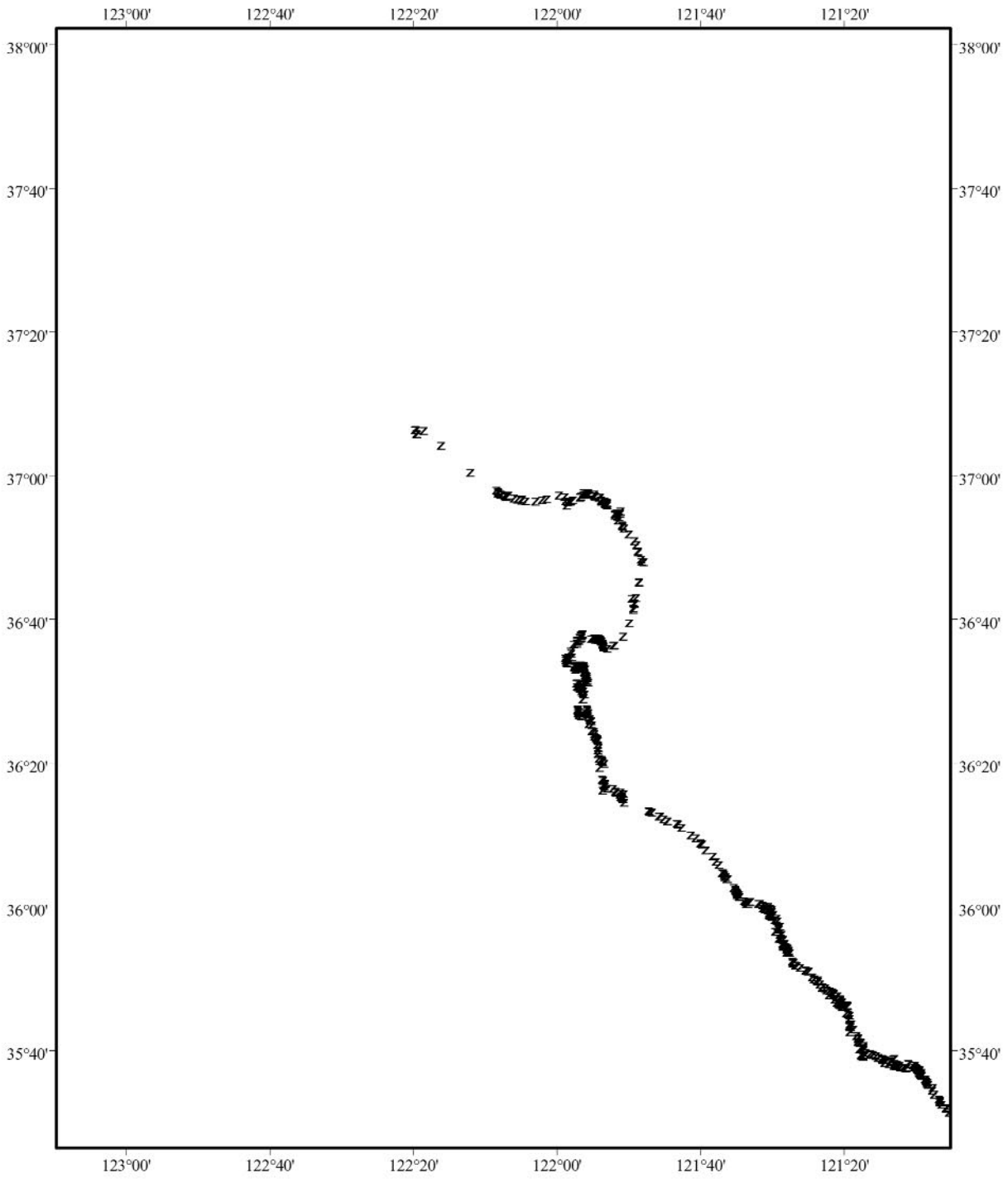
Prevailing Winds
Davidson Current

GIS OVERLAY


Monterey Bay National Marine Sanctuary
Sea Otter Sightings, 1992
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122°40'
122°20'
122°00'
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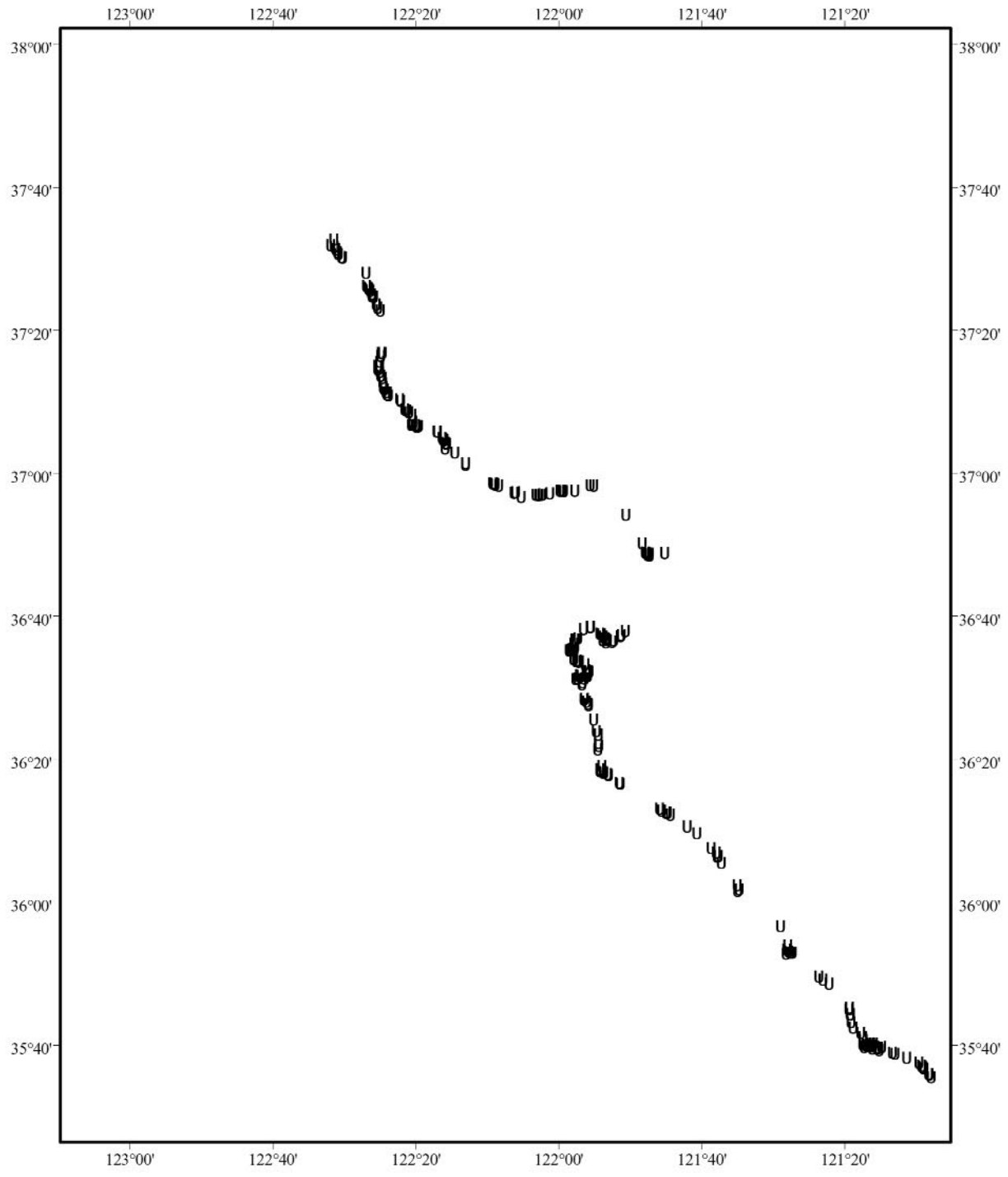
GIS OVERLAY


Monterey Bay National Marine Sanctuary
Pinniped Haul-Out Areas
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122°20'
122°00'
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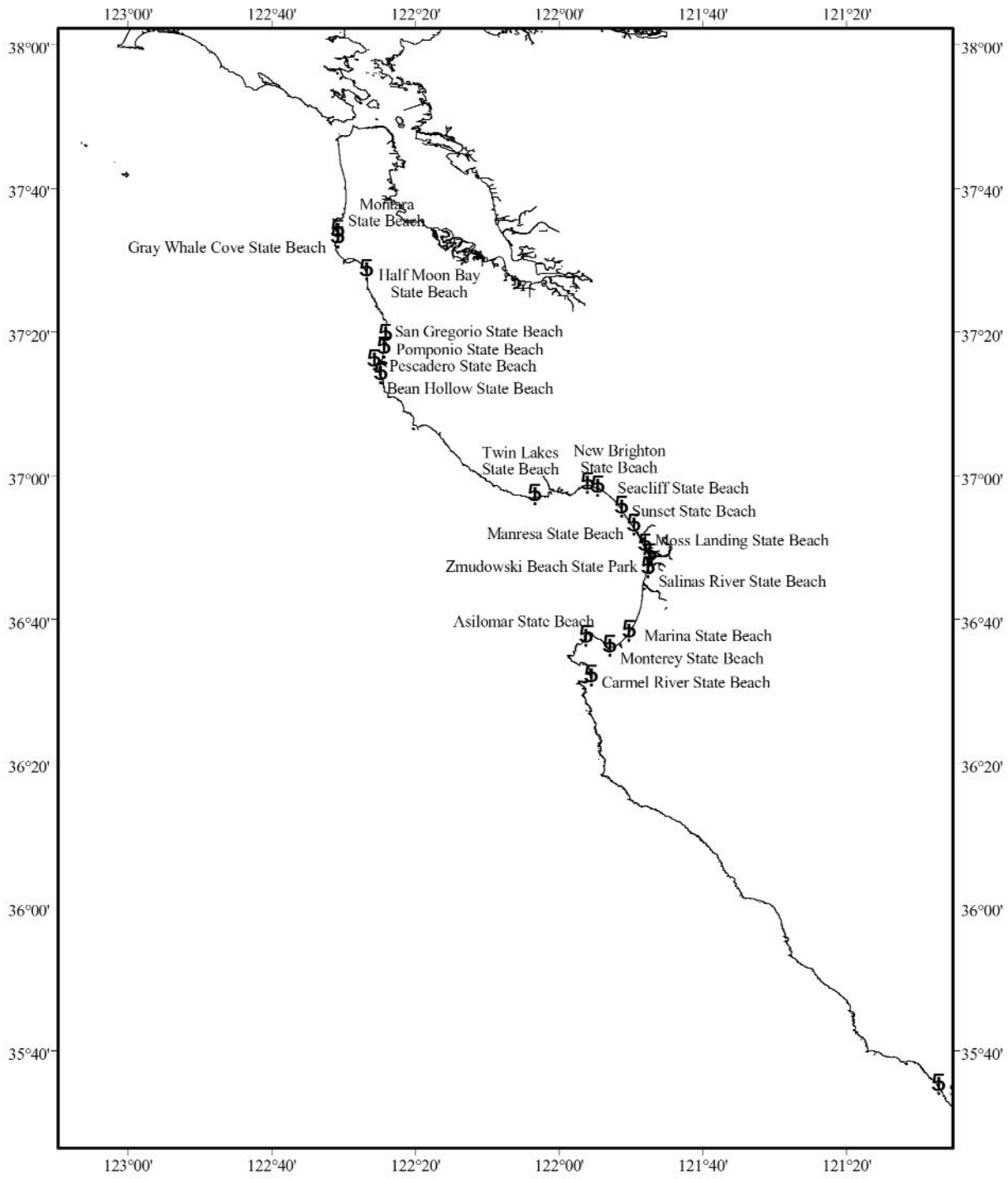
GIS OVERLAY


Monterey Bay National Marine Sanctuary
Recreational Areas
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37°20'
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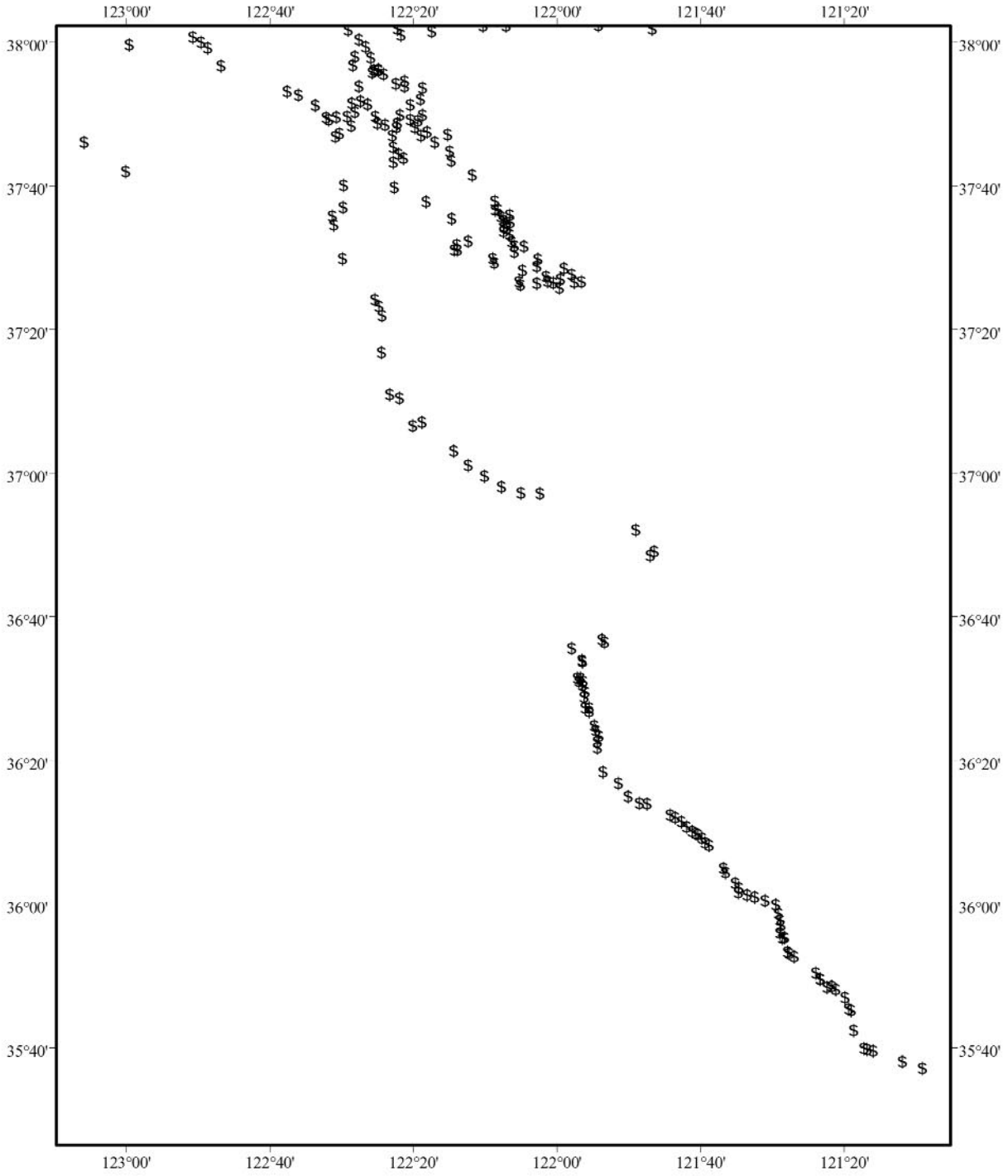
35°40'
Montara State Beach
Gray Whale Cove State Beach
Half Moon Bay State Beach
San Gregorio State Beach
Pomponio State Beach
Pescadero State Beach
Bean Hollow State Beach
Twin Lakes State Beach
New Brighton State Beach
Seacliff State Beach
Sunset State Beach
Manresa State Beach
Moss Landing State Beach
Zmudowski Beach State Park
Salinas River State Beach
Asilomar State Beach
Marina State Beach
Monterey State Beach
Carmel River State Beach

GIS OVERLAY

Monterey Bay National Marine Sanctuary

Sea Bird Nesting Areas



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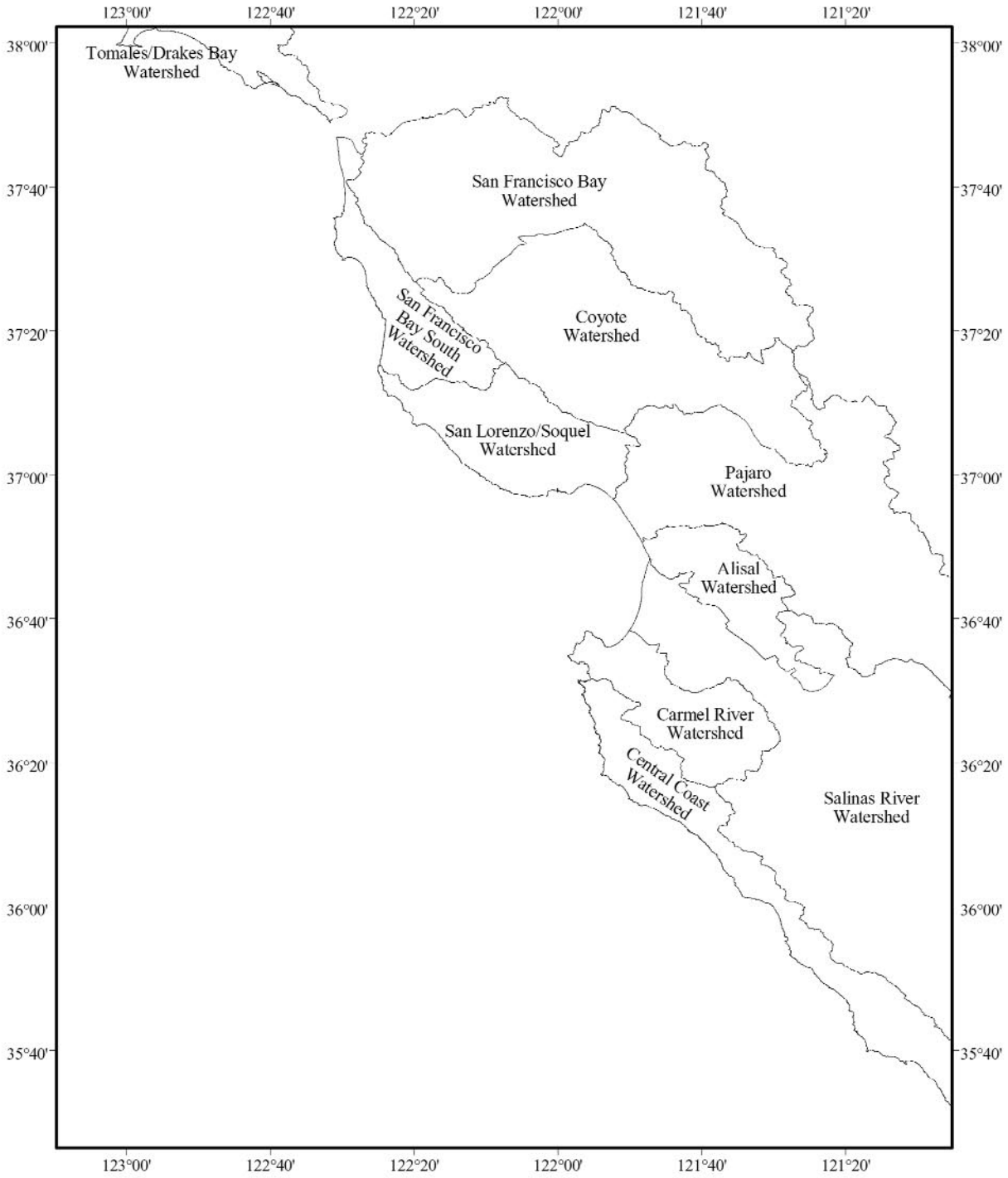
Monterey Bay National Marine Sanctuary
Coastal Watersheds
123°00'
122°40'
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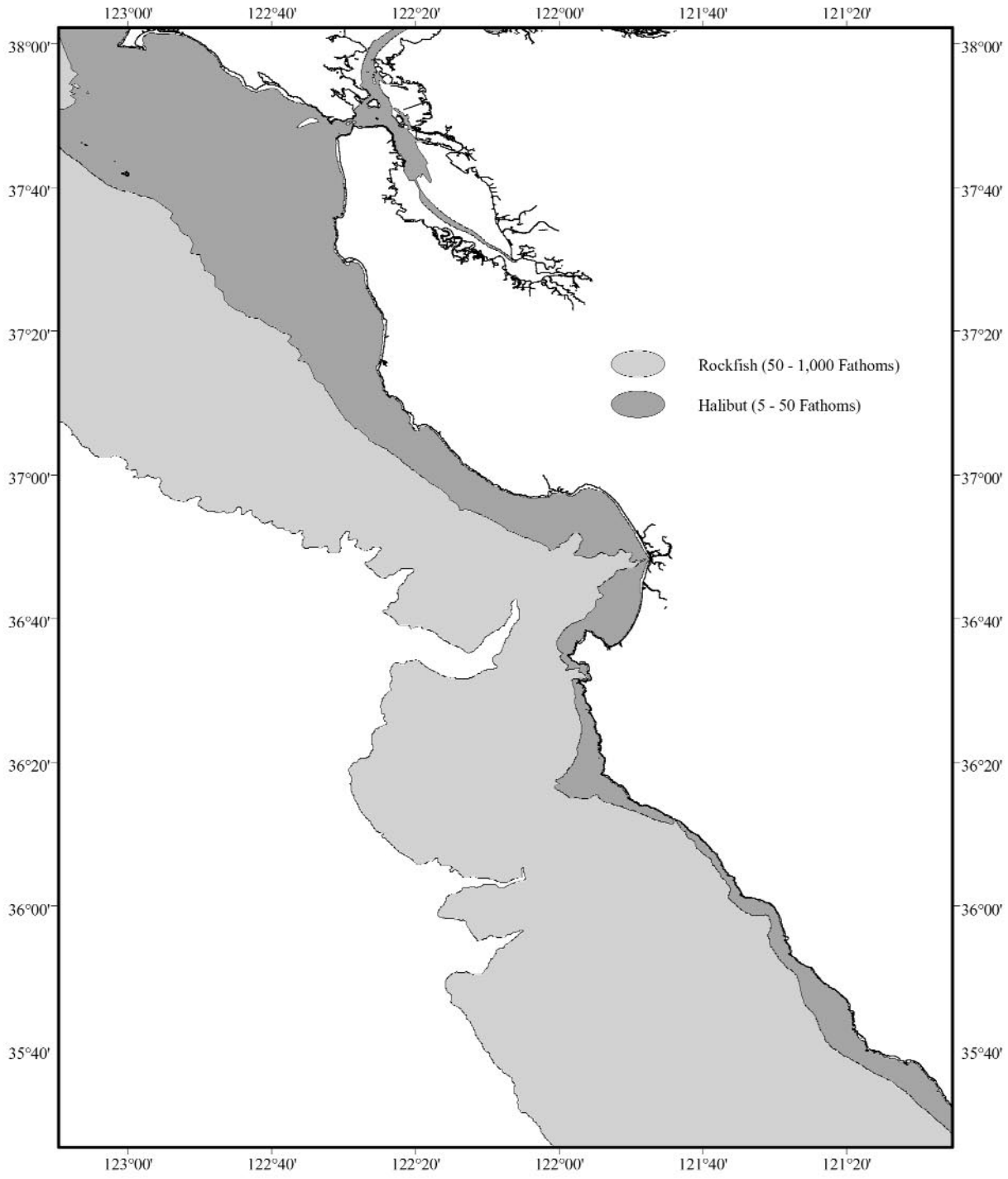
35°40'
Tomales/Drakes Bay Watershed
San Francisco Bay Watershed
San Francisco Bay South Watershed
Coyote Watershed
San Lorenzo/Soquel Watershed
Pajaro Watershed
Alisal Watershed
Carmel River Watershed
Central Coast Watershed
Salinas River Watershed

GIS OVERLAY

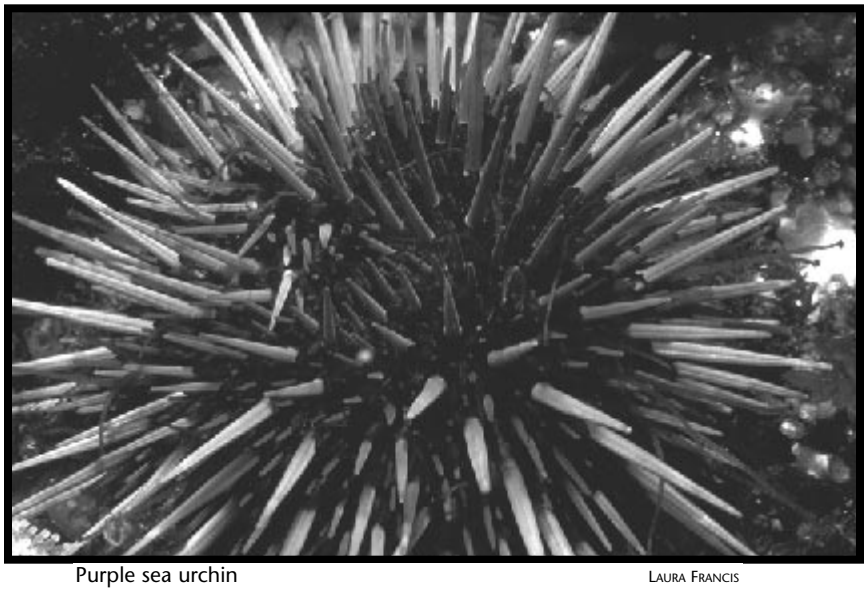
Monterey Bay National Marine Sanctuary

Fishery Areas



INVESTIGATION 2

A Close Look at Monterey Bay National Marine Sanctuary



Purple sea urchin LAURA FRANCIS

In this investigation, students take a close look at Monterey Bay National Marine Sanctuary. After becoming familiar with a bathymetric/topographic map of the area, students select a transect along the seafloor to study some of the geological, biological, and physical features that are present.

ACTIVITY

Conducting a Transect Along the Seafloor: Monterey Bay National Marine Sanctuary

LEARNING OBJECTIVES

Students will:

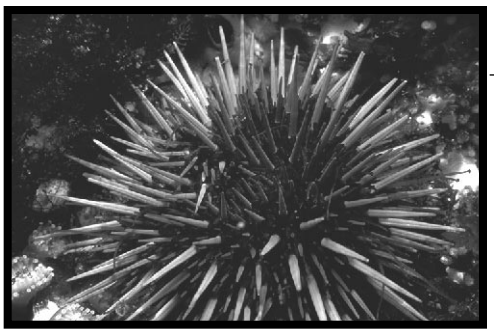
- Use a bathymetric/topographic map as a tool for recognizing geobiological features of the Sanctuary;
- Create a depth profile from a topographic map;
- Use a transect as a tool for quantifying geological, physical, and biological features along the seafloor;
- Correlate species with habitat type in Monterey Bay National Marine Sanctuary.

STANDARDS

Geography Standard 1
How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

Science Standard
Develop abilities necessary to do scientific inquiry

Develop understanding of populations and ecosystems



ACTIVITY

Conducting a Transect Along the Seafloor:

NOAA's Monterey Bay National Marine Sanctuary

Guiding Question

If you were to conduct a horizontal transect in Monterey Bay National Marine Sanctuary, based upon the habitat types along your transect, what species would you expect to find?
(See pages 3-4.)

Materials

- ❑ **Monterey Bay Sanctuary Bathymetric Chart**, one for each group
- ❑ **Benthic Habitat Types in the MBNMS Area**, one for each group
- ❑ **Animal Species in the MBNMS Area**, one for each group
- ❑ Metric ruler
- ❑ Graph paper with x- and y-axis
- ❑ Access to the Internet (optional)

Discussion

As a result of extensive studies of the seafloor in Monterey Bay National Marine Sanctuary, much is known about its topography and sediment types. Sediment type is one of many factors that define the kinds of algae and animals living in a particular area. By knowing these sediment types, and the habitats preferred by different species, scientists can predict what organisms they might find in an area. Using underwater submersibles and other scientific equipment, scientists can compare their predictions with actual findings.

MBNMS contains one of the world's most geologically diverse and complex seafloors and continental margins. The MBNMS is located on a plate boundary which separates the North American Plate from the Pacific Plate, and is marked by the San Andreas fault system. This is an active tectonic region with common occurrences of earthquakes, submarine landslides, flood discharges and coastal erosion. It is also a region of extensive natural and economic resources. Coastal topography varies greatly, encompassing steep bluffs with flat-topped terraces and pocket beaches to the north; large sandy beaches bordered by cliff and large dune fields mid-sanctuary; and predominately steep, rocky cliffs to the south. Low-to high-relief mountain ranges and broad, flat-floored valleys are prevalent farther inland. (From Geology section of MBNMS Site Characterization at website: http://bonita.mbnms.nos.noaa.gov/sitechar/geol2.html#2b)

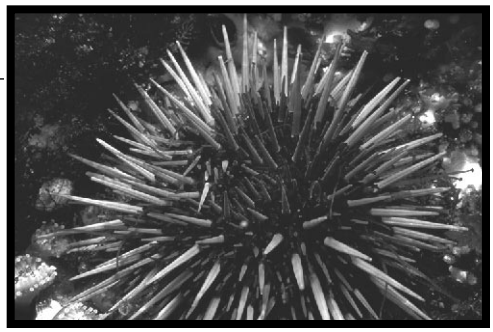
The information for this activity may be substituted with that from another sanctuary. For example, the Florida Keys National Marine Sanctuary website has information about the coral reef habitat. Check out http://www.fknms.nos.noaa.gov.

Procedure

Give each student a copy of the MBNMS Chart.

1 Discuss with your students the different features on the map (contour lines reveal different seafloor features such as the continental shelf, canyons, seamounts, and banks). Discuss how geologists create these maps. (See below.) What are some ways scientists might use these maps? (Map data allows us to get a picture of the seafloor & its habitats. This tells us a lot about what plants and animals live there).

2



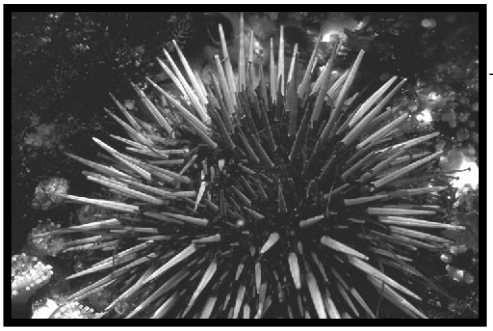
Explain to students that scientists conduct transect studies as one way to characterize the geological, physical, and biological characteristics of an ecosystem. Tell students that they are going to plan a research cruise in the Monterey Bay Sanctuary using an underwater submersible.

HOW ARE SEAFLOOR MAPS CREATED?

Most of our knowledge about seafloor topography comes from soundings: sending sound waves into the water and measuring the time it takes for them to bounce off the ocean floor and return. From these soundings, scientists can create a map of the seafloor.

The device used to send sound waves is called an echo sounder, or sonar. Towed behind a ship, it bounces about 120 narrow beams of sound, also called "pings," off the seafloor several times per second. Another instrument collects the sound that echoes back. The ship passes back and forth over a given area, much the way you mow a lawn, sending these many beams of sound as it goes. A computer on board the boat calculates the depth based on the time it takes for the echo of the beam to return to the surface. Sound travels through the ocean at an average speed of 1,460 meters (4,800 feet) per second. (Sound travels about five times faster through water than it does through air.) To calculate the depth, divide the total amount of time it takes for a ping to hit the bottom and bounce back by two. (You divide by two because the total includes the trip down and back.) Then multiply that figure by 1,460. For instance, if it takes two seconds for sound to return to the ship, the water must be 1,460 meters deep.

At the same time, the sonar gathers information about the composition of the ocean floor by measuring the strength of the returning signal. For example, mud absorbs sound, therefore a muted echo indicates a muddy bottom. A strong echo indicates a rocky bottom. Scientists supplement these sonar images with videos, still photographs, and samples. of the ocean floor. For more information on seafloor mapping, see:http://sustainableseas.noaa.gov/missions/channel2/background/sonar.html



Please see "Meet DeepWorker" background information on page 5. Have students select a horizontal transect on their maps that they would be interested in studying. How do you determine the length and depth of a transect? The transect should be a straight line from one point on the map to another. Using a ruler, have each student draw a straight line on their map to indicate the location of the transect.

3 To help illustrate the underwater topography along a transect, have students make profile charts. On a separate piece of paper, have them create a "T" table: one column for distance from the starting point of their transect (Point A) and one for depth of the seafloor. Then have them collect data at every centimeter along their transect using the scale 1cm = 1 km. For example, measuring one centimeter on the ruler from Point A (which is equal to one kilometer from the starting point of their transect), the contour line indicates depth is 25 meters. At two centimeters (or two kilometers from Point A), the depth is 30 meters. (See following example).

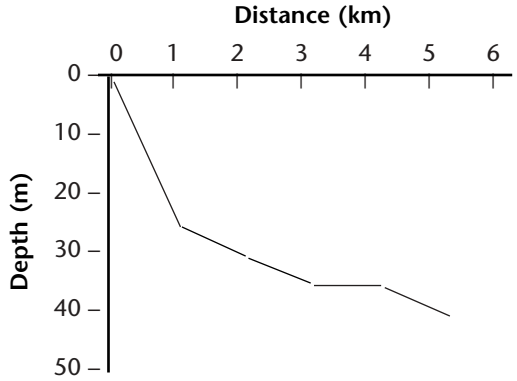
MAPPING THE SEAFLOOR DATA
TRANSECT IN MONTEREY BAY NATIONAL MARINE SANCTUARY

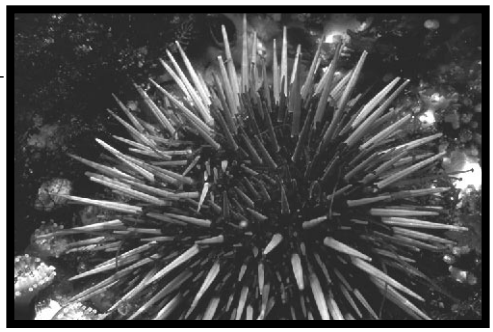
Distance from start (Point A) of transect (m)	Depth of Seafloor (km)
0 km	0 m
1 km	25 m
2 km	30 m
3 km	30 m
4 km	35 m

4 Once students have collected data along their transects and created data tables, have them create profile charts to show the underwater topography. If computer graphing capabilities are not available, hand out graph paper and have students title and label their graphs: distance (km) along the bottom or X axis, and depth increments (m) along the side or Y axis. Students can refer to their data tables for ranges of values.

5 Have students use their data tables to plot the points on their profile charts, then draw a profile by connecting the points on the chart.

Sample Profile Chart





6 Give each student a copy of the **Benthic Habitat Types** handout. Have them determine what kinds of sediments they would find along their transects and indicate these on their maps. Encourage students to ask questions about their findings; for instance, "Where did these sediments come from?," "How did they get here?," "Why are they distributed as they are in different zones?" Students may not have answers to these questions, but asking them is an essential part of doing science and is the first step in scientific inquiry. For more information, refer to the book "Natural History of Monterey Bay National Marine Sanctuary."

7 Give each student a copy of the **Animal Species** handout. Based on the sediments found along their transects, what species would they expect to find? What is their reasoning to support these expectations?

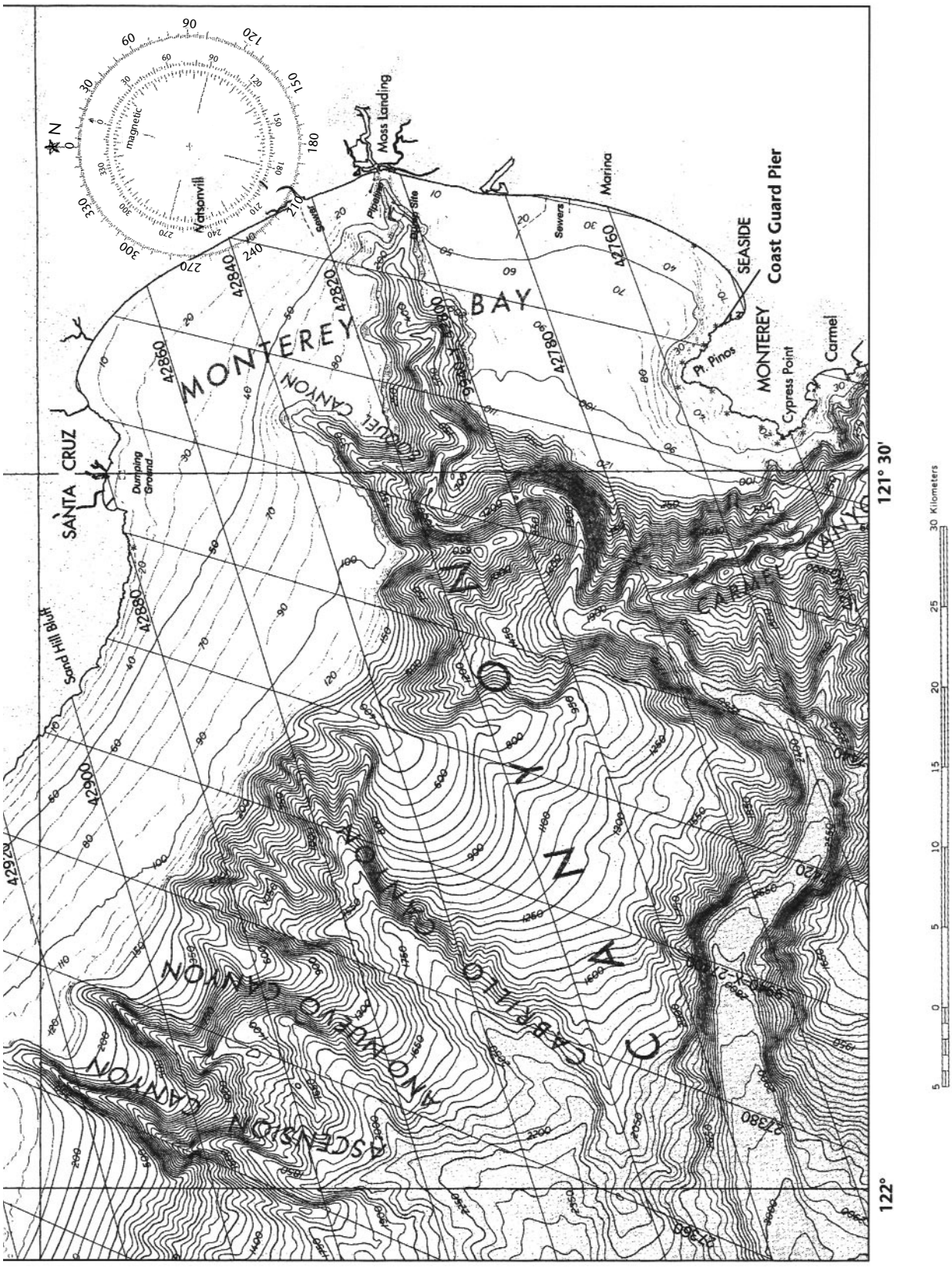
8 Discuss with students the relationships among the organisms, their physical surroundings, and their geographical location. What physical conditions does each organism favor? Does the organism's predators and prey favor the same conditions? What kinds of patterns can be seen among organisms, physical conditions, and their geographical location?

9 If you have access to the Internet, have students refer to the *Sustainable Seas Expeditions* website (http://www.sustainableseas.noaa.gov) to follow the research being conducted in Monterey Bay National Marine Sanctuary. What species are the *Sustainable Seas Expeditions* researchers finding? How do these findings compare with the predictions made by students?

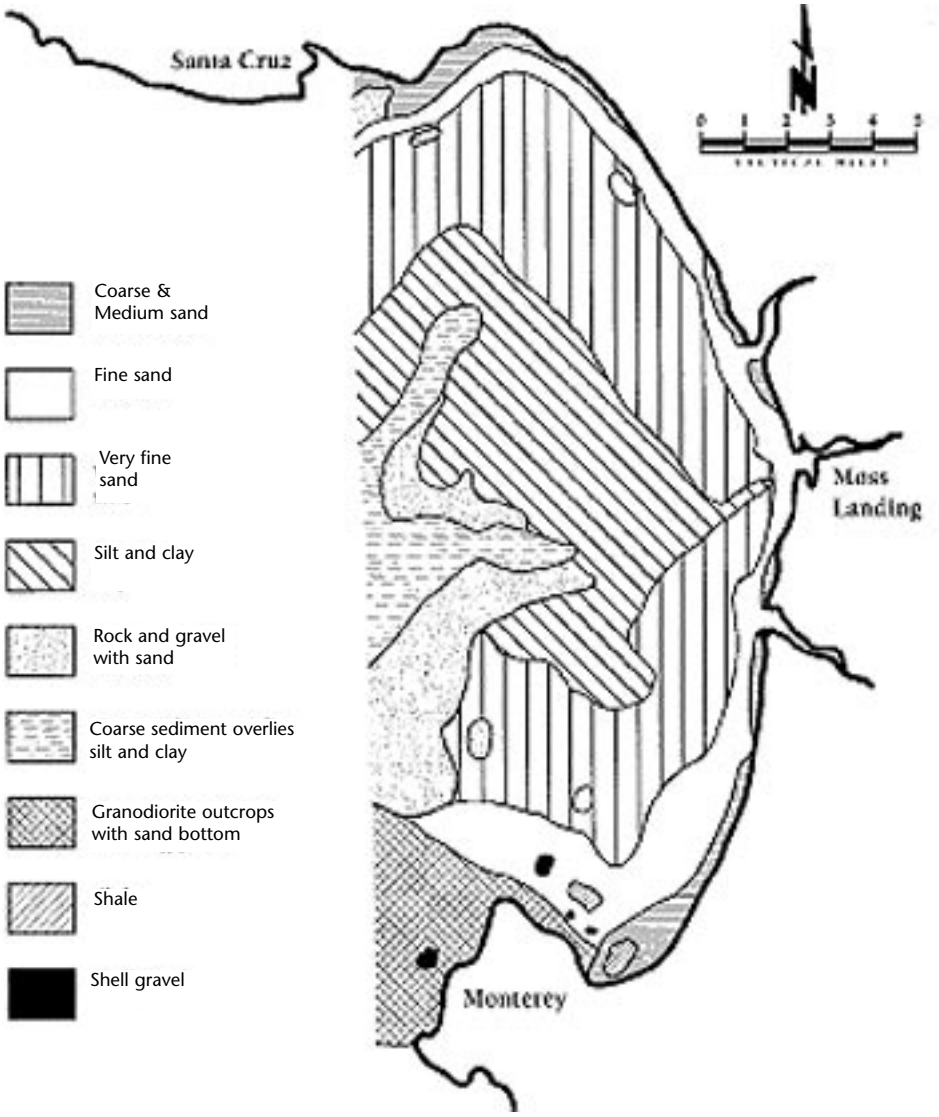
10 Have students write a detailed description of their findings. If they were able to follow the *Sustainable Seas Expeditions* research project on the web, have them draw conclusions about their predictions and the actual findings.

One of the fishes inhabiting NOAA's Monterey Bay National Marine Sanctuary is the center of study for an *Expeditions* investigation. Rockfish (*Sebastes spp.*) congregate in particular habitats in MBNMS. A related species, the Redfish (*Sebastes fasciatus*) inhabit similar areas in NOAA's Stellwagen Banks National Marine Sanctuary. By comparing the day and night habits of these two fish, scientists hope to find relationships between them which might prove useful when making decisions to best protect their populations.

MONTEREY BAY SANCTUARY BATHYMETRIC CHART



BENTHIC HABITAT TYPES IN THE MONTEREY CANYON AREA



*drawing from "Natural History of the Monterey Bay National Marine Sanctuary" available from the Monterey Bay Sanctuary Foundation at website: www.MBSF.org

Common Name: Olive snail
Scientific Name: Olivella biplicata
Habitat Preference: fine sand
Prey: algae & dead animals
Predators: sea stars

Common Name: Red octopus
Scientific Name: Octopus
Habitat Preference: rocky outcrops
Prey: small crustaceans, mollusks and fishes
Predators: demersal fish, herring, striped bass, sea turtles, humans

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Common Name: Pismo clam
Scientific Name: Tivela stultorum
Habitat Preference: coarse and medium sand
Prey: phytoplankton, small detritus
Predators: sea otters, crabs, moon snails, sharks, rays, shore-birds, & humans

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Common Name: Cold seep clams
Scientific Name: Calyptogena spp.

Habitat Preference: Cold seep areas in the deep canyon floor.
Coarse sediment with silt and clay
Prey: chemosynthetic bacteria live in the clams gill tissues and provide their sole source of nutrition
Predators: unknown

Common Name: Sea stars
Scientific Name: Patira miniata (bat star), Pisaster giganteus(Giant seastar), Astropecten armatus (sand star),
Habitat Preference: coarse and medium sand, rocks
Prey: bivalves, small crustaceans, worms, other echinoderms, detritus, carcasses, tunicates, hydroids, sea anemones, sponges
Predators: larger sea stars, gulls & humans

Common Name: Hydroid
Scientific Name: Aglaophenia spp. (ostrich-plumed)
Habitat Preference: gravel, sand
Prey: zooplankton, phytoplankton, small detritus
Predators: nudibranchs, echinoderms, benthic fish (flounders, sculpins)

Common Name: Nudibranchs & Opistobranchs
Scientific Name: Anisodoris noblis (Sea lemon), Pleurobrachia california (Deep sea hare)
Habitat Preference: rocky outcrops
Prey: (selective by species) hydroids, sea anemones, ceri-anthids, corals, bryozoans, sponges
Predators: sea stars, crabs, lobster, some benthic fish

Common Name: Tube-dwelling anemone
Scientific Name: Pachycerianthus fimbriatus
Habitat Preference: fine sand or mud
Prey: small zooplankton, detritus, small animals that get caught on tentacles
Predators: nudibranchs, sea stars, some bottom-feeding fish (cod, flounder, haddock)

Common Name: Sea anemones
Scientific Name: Corynactis californica (strawberry anemone), Metridium senile (plume anemone)
Habitat Preference: rocks
Prey: zooplankton, detritus, small animals that get caught on tentacles
Predators: nudibranchs, sea stars, bottom-feeding fish

Common Name: Crabs
Scientific Name: Cancer magister (dungeness crab), Pagurus samuelis. (hermit crab)
Habitat Preference: boulders, gravel
Prey: phytoplankton, protozoa, small detritus
Predators: nudibranchs, sea turtles, sea urchins, sea stars

Common Name: Bryozoans
Scientific Name: Filicrisia franciscana
Habitat Preference: rocks & shale
Prey: phytoplankton, protozoa, small zooplankton, small detritus
Predators: nudibranchs, crabs

Common Name: Tunicate (carnivorous)
Scientific Name: Megalodicopia hians
Habitat Preference: deep area of canyon walls
Prey: copepods, krill, & other zooplankton
Predators: unknown

Common Name: Giant tube worms (grow up to 1 meter long)
Scientific Name: Riftia spp.
Habitat Preference: hot hydrothermal vents found on the deep seafloor of the canyon; shale and mud
Prey: chemosynthetic bacteria live in the worms tissues and provide nutrition
Predators: unknown

Common Name: Sand dollar
Scientific Name: Dendraster excentricus
Habitat Preference: fine sand & muddy bottoms
Prey: benthic algae, bryozoans, encrusting sponges, small detritus, small copepods
Predators: sheephead, starry flounder, pink sea star, gulls

ANIMAL SPECIES IN THE MONTEREY BAY NATIONAL MARINE SANCTUARY

Common Name: Purple sea urchin
Scientific Name: Strongylocentrotus purpuratus
Habitat Preference: rocky outcrops
Prey: benthic algae, small detritus, plankton
Predators: sea stars, some fishes (California sheephead), sea otters, & humans

Common Name: Common squid
Scientific Name: Loligo opalescens
Habitat Preference: open water, muddy sand (for spawning)
Prey: shrimplike crustaceans, small fishes, benthic worms, & their own young
Predators: Many fishes, birds, marine mammals & humans

Common Name: Blue rockfish
Scientific Name: Sebastes mystinus
Habitat Preference: kelp plants & rocky areas
Prey: mollusks, squid, crustaceans, worms,
Predators: bigger fishes, young preyed upon by many pelagic species, humans

Common Name: Cabezon
Scientific Name: Scorpaenichthys marmoratus
Habitat Preference: rock & gravel
Prey: demersal fish, abalone, crustaceans, mollusks, echinoderms, worms, also scavenges on carcasses
Predators: humans

Common Name: Tidepool sculpin
Scientific Name: Oligocottus maculosus
Habitat Preference: shallow rocky areas
Prey: demersal fish, crustaceans, mollusks, echinoderms, worms, also scavenges on carcasses

Predators: young eaten by many bottom fish

Common Name: California halibut
Scientific Name: Paralichthys californicus
Habitat Preference: fine or coarse sand
Prey: small fishes, crustaceans
Predators: pelagic and benthicl fish, squid, marine mammals, sea birds

Common Name: Pacific herring
Scientific Name: Clupea harengus
Habitat Preference: open water, gravel for egg laying
Prey: small fish, zooplankton (especially copepods), amphipods, mysids, shrimps, worms
Predators: many pelagic and benthic fish, squid, marine mammals, sea birds, humans


Common Name: Lanternfish
Scientific Name: Myctophidae
Habitat Preference: open water in the deep sea
Prey: copepods & euphausiids
Predators: deep sea fish such as barracudinas & squid

Common Name: Speckled sanddab
Scientific Name: Citharichthys stigmaus
Habitat Preference: fine sand
Prey: Mostly crustaceans, plus worms and fishes.
Predators: Diving birds like cormorants, marine mammals, crabs, and other fishes

Common Name: Spiny dogfish
Scientific Name: Squalus acanthias

Habitat Preference: gravel, sand
Prey: small fish (pelagic and benthicl), squid, crustaceans, bivalves, worms, jellyfish, salps
Predators: other dogfish, large sharks, humans

Common Name: Shiner surfperch
Scientific Name: Cymatogaster aggregata
Habitat Preference: kelp forest, rocks
Prey: Eats small crustaceans, algae, and sometimes worms and molluscs.
Predators Birds, fishes, and marine mammals. Often caught by sportfishermen, usually from piers.

Common Name: Northern anchovy
Scientific Name: Engraulis morda
Habitat Preference: open water
Prey: Filters phytoplankton and zooplankton through its fine gill rakers.
Predators: Virtually all predatory birds, fishes (including white croakers), and mammals eat anchovies. Some pizza-lovers too. Often used as bait.

Common Name: Bat ray
Scientific Name: Myliobatis californica
Habitat Preference: sand & mud
Prey: Clams, oysters, snails, crabs, and worms.
Predators: Some humans, and possibly hammerhead sharks

Common Name: Leopard shark
Scientific Name: Triakis semifasciata
Habitat Preference: sand & mud
Prey: Bottom-dwelling fishes and invertebrates.
Predators: Humans are the main predators of adult sharks. Young ones may be vulnerable to marine mammals, adult sharks, and large fishes.

MONTEREY BAY NATIONAL MARINE SANCTUARIES

Glossary

Abyssal: referring to the deep sea or abyss

Bank: an undersea elevation rising from the continental shelf

Bathymetry: the measurement of depths of water in oceans, seas, and lakes

Bay: a small body of water set off from the main body; an inlet of the sea usually smaller than a gulf

Benthic: near or on the bottom

Canyon: a deep narrow valley with steep sides and often with a stream flowing through it

Cape: a point or extension of land jutting out into water as a peninsula or point

Continental Shelf: an old, wave-cut terrace gently sloping seaward

Continental Slope: beyond the shelf, the slope descends more steeply into the ocean shelf

Creek: a stream of water smaller than a river, often a tributary to a river

Davidson Current: warm ocean current flowing northward between the shoreline and the California Current along the west coast of the U.S. during winter months

Detritus: particles of debris from decaying plants and animals

Ecology: scientific discipline involving interrelationships among animals, plants and their environment

Estuary: where river currents meet and are influenced by oceanic tides

Fan: (also called an alluvial fan) deposits from a stream that form a gently sloping fan-shaped sediments, often seen at the base of a hill or gorge

Geography: the science or the study of earth and its life; a description of land, sea, air and the distribution of plant and animal life including people and cities

Geology: the science or the study of the earth and its history as recorded in rocks

Gulf: a part of the ocean or sea extending into the land

Hydrology: the science or the study of bodies of water such as the measurement of flow in streams

Island: land surrounded on all sides by water and smaller than a continent

Latitude: the angular distance north or south of the equator, measured in degrees along a meridian, a on a map or globe

Longitude: the angular distance on the earth, as on a globe or map, east or west of the prime meridian at Greenwich, England, to the point on the earth's surface for which the longitude is being ascertained, expressed in degrees, or in hours, minutes or second

Meander: a turn or winding area of a stream

Mount: a high hill

Midden: a refuse heap, a dump, especially referring to Indian kitchen middens

Oceanography: study of the physics, chemistry, biology and geology of the worlds oceans

Peak: the top of a hill or mountain ending in a point

Pelagic: of the open oceans

Plankton: plants and animals that swim weakly, or not at all, and drift with ocean currents

Point: a projecting area of land or a sharp prominence

Predator: a animal that kills and eats other animals

Glossary & Teacher Resources

Range: a series of mountains

Ridge: (on land) a range of hills or mountains (on the ocean floor) an elongated elevation on the ocean bottom

River: a natural stream of water usually large and long

Sanctuary: a safe place of refuge and protection

Sea Level: the level of the surface of the sea; a mid-point between the high and low tide

Seamount: a submarine mountain rising above the deep sea floor

Stakeholder: a citizen with a vested interest in a certain resource

Submarine Canyon: a long, narrow, steep-walled undersea valley

Substrate: any surface on which a plant or animal lives or on which a material sticks

Taxonomy: scientific classification of animals and plants

Transect: a monitoring research technique that marks a transverse along which measurements can be taken

Topography: a graphical representation of the physical features of a place or region on a map

Valley: a long, low area of land usually between hills or mountains drained by a river

Watershed: a region or area connected by a body of water, rivers and drainage

Monterey Bay National Marine Sanctuary

299 Foam Street
Monterey, CA 93940
831-647-4201 (phone)
831-647-4250 (fax)
Web address: www.mbnms.nos.noaa.gov

Brochures and Flyers

Monterey Bay National Marine Sanctuary general brochure
Kayaking in the Monterey Bay National Marine Sanctuary brochure
Diving in the Monterey Bay National Marine Sanctuary brochure
Boating in the Monterey Bay National Marine Sanctuary brochure
Motorized Personal Watercraft in the Monterey Bay National Marine Sanctuary brochure
Together We Can—sanctuary flyer and coloring page (available in English and Spanish)
Citizen's Guide to Clean Water and the Monterey Bay National Marine Sanctuary brochure
Monterey Bay Begins on Your Street—brochure on urban run-off (available in English and Spanish)
Monterey is Closer Than You Think brochure

Newsletters

News from the Monterey Bay National Marine Sanctuary newsletter (3 issues/year)
Monterey Bay National Marine Sanctuary—Your Guide to its Natural History and Recreation newspaper

Books

A Natural History of the Monterey Bay National Marine Sanctuary
Sanctuary Explorations

Posters and Charts

Monterey Bay National Marine Sanctuary—nautical chart
Monterey Bay National Marine Sanctuary—poster
Are you Feeding Our Wildlife?—water quality poster
Monterey Bay National Marine Sanctuary Anniversary annual poster
Storm Drains Lead Straight to the Ocean poster
Good Cleaning Practice—poster for Auto Repair Industry
Good Cleaning Practice—poster for Food and Restaurant Industry
Monterey Submarine Canyon poster

Videos

Monterey Bay National Marine Sanctuary—A National Treasure (20 minutes)
Visitor's Guide to the Monterey Bay National Marine Sanctuary (12 minutes)
Dive into Fishwatching
Watersheds to Seashores (25 minutes)

Volunteer Opportunities

Monterey Bay National Marine Sanctuary internships
BeachCOMBER volunteers
Save Our Shore's Sanctuary Stewardship Program
Center For Marine Conservation's BayNet Program
Monterey Bay National Marine Sanctuary Citizen's Stewardship Team

Recommended Local Web Links

American Cetacean Society—Monterey Bay Chapter—www.starrsites.com/acsmb
California Resources Agency—www.ceres.ca.gov
Coastside Live—www.coastside.net/COASTSIDE_Live
Internet Monterey Bay—www.bayotter.com
Local Oil Recycle Centers - www.ciwmb.ca.gov/wpe/usedoil/hotvb.asp
*Local Marine Science/Education/Conservation Organizations: www.*bonita.mbnms.nos.noaa.gov/intro/local_institutions.html
National Geographic: Sustainable Seas: www.nationalgeographic.com/seas
Santa Cruz Harbor: www.santacruzharbor.org

Monterey Bay National Marine Sanctuary
Teacher Curriculum "The Land-Sea Connection"

EVALUATION FORM

Thank you for taking the time to complete this Evaluation Form. Your comments will help us improve the educational materials that we develop in the future.

1. Circle the grade level(s) you teach:

6 7 8 9 10 11 12

2. I teach (circle all that apply):

Geography Life Science Physical Science Earth Science Social Science

Other: _____

3. Rate the Curriculum in terms of quality.

High quality				*Low quality*
1	2	3	4	5

4. Rate the Curriculum in terms of usefulness.

Very useful				*Not useful*
1	2	3	4	5

5. The materials and activities are written at a level appropriate for a middle and high school audience.

Strongly agree	*Agree*	*Not sure*	*Disagree*	*Strongly disagree*
1	2	3	4	5

6. These materials address my needs to teach to the local, state, and national standards in science and geography.

Agree *Disagree*

7. Suggestions for improvement:

8. Did you notice student learning as a result of using these materials? Please explain your observations and conclusions.

9. Are there any activities, background information, or resources for teachers and students that you recommend adding to these materials? Please include copies of your activities.

Please send your completed Evaluation Form to:

Monterey Bay National Marine Sanctuary
Attention: Education Department
299 Foam Street
Monterey, CA 93940