Ocean Exploration off the West Coast of the U.S.

A Voyage of Discovery to Unexplored Marine Habitats in the Northeast Pacific - Completing the Lewis and Clark Legacy

Overview

Large decreases in both fish and invertebrate communities around the world have produced deep anxiety about the long-term health of seafloor ecosystems. This concern is heightened by the likelihood that anthropomorphic effects may be responsible for a large portion of these decreases (Koslow, 2000). The true human impact on the extent of these declines is unknown, however, because in many areas *exploitation by commercial interests has preceded exploration by the scientific community*. Whatever portion of the blame society must shoulder, there is little doubt that determination of the extent of habitat alteration is challenging. One of the major difficulties in studying and monitoring many of the easily accessible seafloor habitats is their disturbed nature. A new thrust in ocean exploration can have a positive impact on this situation because there is a good chance that there are ecosystems off the west coast that have been left relatively undisturbed due to remoteness and/or rough bottom characteristics. It is ironic that even after more than 40 years of ocean research off the west coast of the U.S., there are many places virtually unexplored by modern technology. Over the next several years, we propose to investigate marine habitats that represent relatively "neglected" major submarine provinces. The following presents examples of two major submarine provinces in the Northeast Pacific, the first, submarine canyons, will be the focus of our exploration efforts in summer 2001.

Submarine Canyons

Submarine canyons are a common feature of many of the world's continental shelf breaks. Owing to their abrupt and steep topography, these canyons often modify the circulation patterns and increase shelf-slope exchange of water masses, nutrients and suspended particles (Baker and Hickey, 1986; Hickey, 1997). They are known to be areas of enhanced productivity due to topographically induced upwelling along their axes (Freeland and Denman, 1982). Canyons also transport large quantities of organic matter offshore through sediment flushing, thus enriching

the deep ocean (Rowe, 1971). These physical processes biologically enrich canyon regions (Denman and Powell, 1984), which may show enhanced concentrations of macrobenthos, micronekton, demersal fishes, and cetaceans relative to the slope as a whole.

Submarine canyons are a good target to explore for natural refugium (Yoklavich et al., 1999). They often have steep walls and rugged terrain that discourage extensive bottom trawling.

The Canyon of the Columbia

Almost 200 years ago, Meriwether Lewis and William Clark and the Corps of Discovery made their historic crossing of the United States. This first exploration of the American west by Europeans was marked not only for its bold thrust into the unknown but also for its scientific return. Descriptions of hundreds of plants and animals previously unknown to science were a lasting legacy of their expedition. However, one area of the North American continental platform inaccessible in the early 19th century was the continental shelf and slope beneath the Pacific Ocean. We propose to complete this historic exploration program. We will map, explore and document the physical and biological systems of the westernmost portion of the Columbia River drainage system, the Astoria Canyon, beginning just 10 miles west of the present mouth of the Columbia River (Figs. 1 and 2). This exploration is particularly fitting in light of the upcoming expedition bicentennial because one of the highest priorities was to explore and map the drainage systems of the western United States. During the low sea level stands of the glacial periods, the Columbia River drained directly into the canyon. Today, the canyon is a virtually unexplored biological haven (Figs. 2 and 3), and an intriguing potential refugium for fish and unusual invertebrate communities such as corals. The active tectonic setting of the canyon and the rich organic supply through time also makes it a likely setting for methane seeps (Chris Goldfinger, Personal Commun.).

With its obvious tie to the Corps of Discovery, we believe exploration of the Astoria Canyon offers an exciting public and educational outreach opportunity.

Seamounts

The floor of the Pacific Ocean is punctuated with hundreds of volcanoes that have been constructed over the past 200 million years. Many of these seamounts rise into the upper portion of the ocean where they alter the hydrography (e.g., Roden , 1991) and create local upwelling zones that stimulate biologic productivity (Boehlert and Genin, 1987; Roger, 1994; Koslow, 1997). Some even rise into the photic zone and create specialized habitats for diverse invertebrate and fish populations. Many of these have already been targets for specialized

fisheries that have severely damaged the ecosystems. Some seamounts, however, are features young enough to still retain a rough volcanic texture that has inhibited the bottom trawling that so damages these ecosystems.

About 250 miles off the coast of Washington and Oregon lies a chain of shallow, young seamounts whose benthic habitats remain relatively unexplored (Fig. 1). Some rise to within 100 meters or less of the sea surface. In the spring of 2000, two of the largest of these seamounts, Cobb and Brown Bear, were surveyed with the Sea Beam system on the NOAA ship *Ronald H. Brown* (Fig. 4). These data provide excellent baseline maps with which to plan exploratory investigations with an ROV. One virtually unexplored aspect of these--or any--seamounts is the role that highly variable near-bottom current patterns play in defining benthic habit zones. A seamount intruding into surface ocean currents creates a clockwise flow (in the northern hemisphere) around the summit that can magnify currents by as much as a factor of 50. Careful ROV transects of the summit and flanks of a seamount, combined with information on the local current regime, could yield important new explanations on how certain environmental factors effect the distribution and success of benthic habitats. We propose to co-locate ROV and current meter observations on a selected seamount environment to explore these habitat issues.

Expedition Strategy - Enhancing Currently Funded Expeditions for Maximum Efficiency

Our overall strategy for the summer of 2001 is to tie the Exploration Program into currently funded projects in order to maximize efficiency in logistical support, personnel, and cost. The Exploration Program will take advantage of the already planned shiptime and logistics for *Ronald H. Brown* and *ROPOS* by complementing an interdisciplinary project on Heceta Bank, OR. Heceta Bank is the site of a funded on-going NOAA NURP program (West Coast and Polar Regions Undersea Research Center) to conduct an interdisciplinary and comprehensive study of the habitats of the Bank using state-of-the-art survey strategies, instrumentation, and data analysis. During summer 2000, a diverse team of marine geologists, fisheries scientists, invertebrate biologists and ecologists, conservation biologists, commercial fisherman and educators, participated in a 10-day cruise with ROPOS to Heceta Bank. Over the course of the past months, they have continued to work on the data and samples collected in preparation for

their second field season in June / July 2001. For our exploration project, we will be able to capitalize on the fact that this previously established team will be working just a few hour's steam from Astoria Canyon. A block of about 5 days can be made available for an ocean exploration component during June-July of 2001, and linked to the existing operations on Heceta Bank. The NOAA Ship *Ronald H. Brown* is ideally suited for this work. It has berthing for up to 34 scientists, a large amount of wet and dry laboratory space and has an advanced dynamic positioning system for holding station and/or maintaining precise heading and speed along a survey line. The NOAA VENTS program and collaborators have successfully used the Canadian *ROPOS* vehicle off the *R/V Thomas G. Thompson* and *NOAA Ship Ronald H. Brown* for the past 3 years. The *ROPOS* is a 30-40 HP electro hydraulic HYSUB ROV capable of operating in up to 5000 meters of water depth. During the summer of 2000, the *ROPOS* was routinely doing over 15 hours per day of bottom time off the new AGOR-class vessels.

In order to enhance and optimize the exploration of Astoria Canyon using the ROV we propose two other short field programs. The first is a detailed sidescan survey of the upper portion of the canyon from the shelf break down to about 2000 m depth. We hope to conduct this survey about 1 month prior to the ROV dives. Currently available high-resolution multibeam bathymetric survey exist covering the Astoria Canyon (Chris Goldfinger, Oregon State University) provide an excellent overview of the canyon morphology and a baseline for more detailed studies. However, deep-towed sidescan will provide the high-resolution imagery necessary to identify rock outcrops, possible methane seeps, unusual features such as submarine sediment slides, and other interesting targets. This program will utilize a chartered deep-towed sidescan / bathymetric mapping system and vessel. A cruise of approximately 7 to 10 days will be sufficient to cover the areas of interest.

This strategy will provide a higher level of visibility that focuses directly on the excitement of going to unexplored areas of the ocean floor. During 2001, we will devote all of our exploration efforts to Astoria Canyon with the Cobb/Brown Bear seamount area reserved for exploration efforts in 2002. The Astoria Canyon cruise will be staged from Victoria, BC, Canada in late June with the cruise ending in Astoria, Oregon, a major port on the Oregon coast (lying at the mouth of the Columbia River). Astoria's historical connection with the Lewis and Clark

expedition makes it an ideal site for ending this leg in the *Ronald Brown's* cruise track. Astoria Canyon is located one half day's steam from Victoria, so that dives can begin the evening of the day of departure and continue until the last day of the cruise. The ROV dives will be 12 to 18 hours in length. Allowing for the rough terrain and sample collections, we estimate that about 15 transects can be made of the canyon walls and floor. These explorations will cover approximately 40 km along the upper part of the canyon over a range of depths from 200 to 2,000 meters (650 – 6,560 feet).

In order to monitor the oceanographic conditions during the time of the field program we will conduct reconnaissance CTD casts, including optical and chemical sensors. Data from these casts will define the distribution of dissolved and particulate materials (nutrients, organic matter) that can affect the health of benthic refugia in the canyon. To translate these distributions into transport through the canyon, we will deploy two moorings with sensors to monitor current flow, particulate matter concentrations, and nutrient concentrations. These measurements will be used to quantify the oceanographic conditions under which biologically important material is transported and concentrated within the canyon.

We will also conduct acoustic transects across the canyon using a towed Simrad Ek500 (38 and 120 kHz) echosounder (or equivalent, e.g., HTI or Biosonics system) or a Simrad SM2000 multibeam (in a towed body) to search for aggregations of fish and zooplankton. The micronekton size fraction of the acoustics survey will be groundtruthed with an Isaacs-Kidd midwater trawl towed from the *Ronald H. Brown*. In addition, the exploration project will take advantage of an ongoing study of the pelagic fishes in the ocean waters off overlying the Canyon – the chartered commercial fishing vessel for this project will conduct sampling with a Nordic 264 rope trawl to provide additional groundtruthing of the nekton size fraction.

Acoustic data collected by the SOund SUrveillance System or SOSUS prior to and during the summer of 2001 will be analyzed and all detected biological and geological sources within the area of investigation will be located and identified. Examples of sources include fault movement, mass wasting, and whale and fish vocalizations.

Partners, Collaborators

List of Primary Investigators:

NOAA:

Waldo Wakefield – NMFS Northwest Fisheries Science Center – Ichthyology, Fisheries Science

Bob Embley - PMEL, Marine Geology

Rick Brodeur - NMFS Northwest Fisheries Science Center – Bioacoustics, Biological Oceanography

Robert Emmett- NMFS Northwest Fisheries Science Center – Biological Oceanography

Mary Yoklavich – NMFS Southwest Fisheries Science Center – Ichthyology, Fisheries Science

Ed Baker - PMEL - CTD Measurements, Sediment Transport

Bill Lavelle - PMEL - Ocean Process Modeling

Chris Fox - PMEL - Acoustics

John Lupton - PMEL - Marine Tracers, Ocean Physics

Ed Bowlby - Olympic Coast National Marine Sanctuary - NOS - Benthic Ecologist

Mary Sue Brancato - Olympic Coast National Marine Sanctuary – NOS - benthic ecologist

Academic:

Brian Tissot (Washington State University, Vancouver) - Invertebrate Ecology

Bill Pearcy - (Oregon State University) - Marine Nekton

Bob Dziak - (Oregon State University) - Geophysics

Chris Goldfinger (Oregon State University) - Marine Geology

Jackie Popp Noskov - (Oregon State University) - Bioacoustics

Bill Hanshumaker - (Oregon Sea Grant) Hatfield Marine Science Center, Marine Educator

John Dower - (U. British Columbia) Marine Micronekton

Private:

Janet Voight - (Field Museum-Chicago) – Cephalopods, and Invertebrate Taxonomy and Systematics

Gordon Hendler - (Los Angeles County Museum) – Echinoderms, and Invertebrate Taxonomy and Systematics

Institutions:
Hatfield Marine Science Center
Oregon State University
Washington State University at Vancouver
Oregon Coast Aquarium
Los Angeles County Museum
Field Museum (Chicago)
University of British Columbia

Education and Media Plan

We consider the outreach component an essential and critical part of the exploration expedition. Since 1998, the PMEL NeMO program has had a successful outreach/education program in collaboration with the education department of the Hatfield Marine Science Center and a WWW site maintained by PMEL and Oregon State University. This existing outreach/educational infrastructure could be extended to include the Northeast Pacific program with minimal cost. We envision 5 public museums and aquaria as partners in the outreach effort, including the Oregon Museum of Science and Technology, Oregon Coast Aquarium, Hatfield Marine Science Center Public Wing, Los Angeles County Museum, and the Field Museum of Chicago. The latter three institutions may have marine educators and/or staff scientists on the expedition. In addition, there would be berths for several Middle and Secondary School teachers and students.

There is an added value as far as outreach and education provided through the linkage between the proposed exploration project and the funded and on-going project on Heceta Bank which would immediately follow the exploration of Astoria Canyon (see time line, below). Coordination between these two projects will in the context of the Exploration Program provide an opportunity to compare and contrast the biological, geological, chemical and physical oceanographic characteristics of these two major submarine provinces in the Pacific Northwest.

Last year, there was an effort to involve in the Heceta Bank Project a number of constituents, including educators, commercial fisherman, and representatives from conservation organizations. Last year's outreach efforts will facilitate our efforts in 2001.

In order to bring the results of the exploration to the nation in an immediate and dramatic sense, we are investigating the possibility of a microwave video link from the seafloor to the shore and hence directly to the Internet and national media. Other exploration projects could use the development of such a portable system in the future. Because the microwave transmission is line-of-sight, the high-resolution format is well suited to the vicinity of Astoria Canyon. For future explorations to locations more distant from the coast, compressed video clips and still photos could be provided either in real time or on a daily basis to the Internet.

Direct participation would be opened to representative(s) of the national media through the NOAA public affairs office. Press conferences will be scheduled before and after the expedition.

Future Explorations in the Pacific Northwest – beyond 2001

In the year following our initial exploration of Astoria Canyon, we anticipate that we would return to the Canyon to build on the discoveries from 2001. In addition, during 2002, we would initiate exploration of Cobb and Brown Bear Seamounts, taking advantage of PMEL's recent multibeam mapping efforts in this submarine province. The exploration of these two seamounts would be conducted aboard the *Ronald H. Brown* with the ROPOS ROV, and also include an array of oceanographic sensors including shipboard ADCP, and moorings to measure currents, particulate matter and nutrient concentrations. An important component of the seamount exploration would be an acoustic survey of the micronekton and nekton inhabiting the pelagic environment in the vicinity of the seamount.

Timeline

April / May / June – conduct sidescan survey of Astoria Canyon and process imagery in preparation for exploration of the Canyon

June 26 - *Ronald H. Brown* arrives in Astoria, Oregon - Load expedition personnel (*ROPOS* staged in Victoria, B. C.) and hold press conference

June 26 - July 1 - Exploration of Astoria Canyon

July 1 - Return to Astoria, post-expedition press conference

July 1 - July 11 - Fish Habitat cruise at Heceta Bank off Oregon

July 11 –opportunity to hold second post-expedition press conference highlighting and linking Astoria Canyon and Heceta Bank projects

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