

MMS OCEAN SCIENCE

VOLUME 3 ISSUE 6
NOVEMBER/DECEMBER 2006

THE SCIENCE & TECHNOLOGY JOURNAL OF THE MINERALS MANAGEMENT SERVICE



**Cooperating for
New Answers
from the OCS**

**The Lower
Tertiary Trend**

**Monitoring the
Flower Garden
Banks**

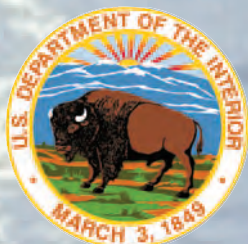
**Cooperative
Conservation
Creates Shared
Resources**

**Cold Water
Cleanup
Research
Produces New
Techniques**

**High-Frequency
Radar (CODAR)
Tests Offer New
Understanding**



MMS *OCEAN SCIENCE* is published bi-monthly by the Minerals Management Service to communicate recent ocean science and technological information and issues of interest related to offshore mineral recovery, ocean stewardship, and mineral revenues.



Please address all questions, comments, suggestions, and changes of address to:

Deborah Epperson

MMS *OCEAN SCIENCE* Editor
Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, LA 70123

deborah.epperson@mms.gov

(504) 736-3257

ABOUT THE COVER

Top: Research diver taking quantitative photos of the Flower Garden Banks. Photo by Gregory S. Boland.

Bottom: Oil platform in the Gulf of Mexico.
Photo courtesy of NOAA

Back: Background platform image by
Gregory S. Boland

*All photos courtesy of Minerals Management Service
unless otherwise noted.*

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COOPERATING FOR NEW ANSWERS FROM THE OCS

What does the future hold for our Nation's energy reserves? Will we be able to locate and develop alternative sources of energy? How will the search for energy resources affect other ecosystems such as coral reefs, or other mammals such as sperm whales? Can agencies, academia, and industry work together to pool resources and information that would be available to all interested parties? Can we stimulate the interest of students to work on these problems and others that have yet to be determined?

These questions and others are being answered by the Minerals Management Service (MMS) and its partners through the spirit of cooperative conservation.

Cooperative conservation is an effort by the U.S. Departments of the Interior, Agriculture, Commerce, and Defense, and the Administrator of the Environmental Protection Agency to include public and private entities and individuals in the management, enhancement, and

protection of our natural resources. This effort to promote collaboration has been facilitated by an executive order from the President of the United States and has been adopted as policy by MMS and its fellow agencies.

As part of this cooperative effort to gain more knowledge about irreplaceable resources in the Gulf of Mexico, MMS is funding studies

Cooperative conservation is an effort . . . to include public and private entities and individuals in the management, enhancement, and protection of our natural resources.

that will determine the possible effect of oil and gas exploration on coral reefs and ways to mitigate any damage that may be found. It is also partnering with academia to investigate the life history of the endangered sperm whale and the possible impacts of oil and gas activities on this species.

The leasing of deepwater blocks in the Lower Tertiary Trend holds the promise of future oil and gas resources. Interest in the trend has escalated due to the recent success of industry tests.

The partnerships and studies add depth to our knowledge base, building an unparalleled reservoir of accessible information about the Outer Continental Shelf. This building process is one of the keys to piquing the imaginations of young scientists and engineers. It is these young explorers who will ask new questions and reveal their answers as we discover more about the inhabitants of our oceans and their relationship with their environment.



Researchers use a RHIB (Rigid Hulled Inflatable Boat) to search for tagged whales during the 2005 Sperm Whale Seismic Study. *Photo by Craig Hayslip.*

NEW DISCOVERIES

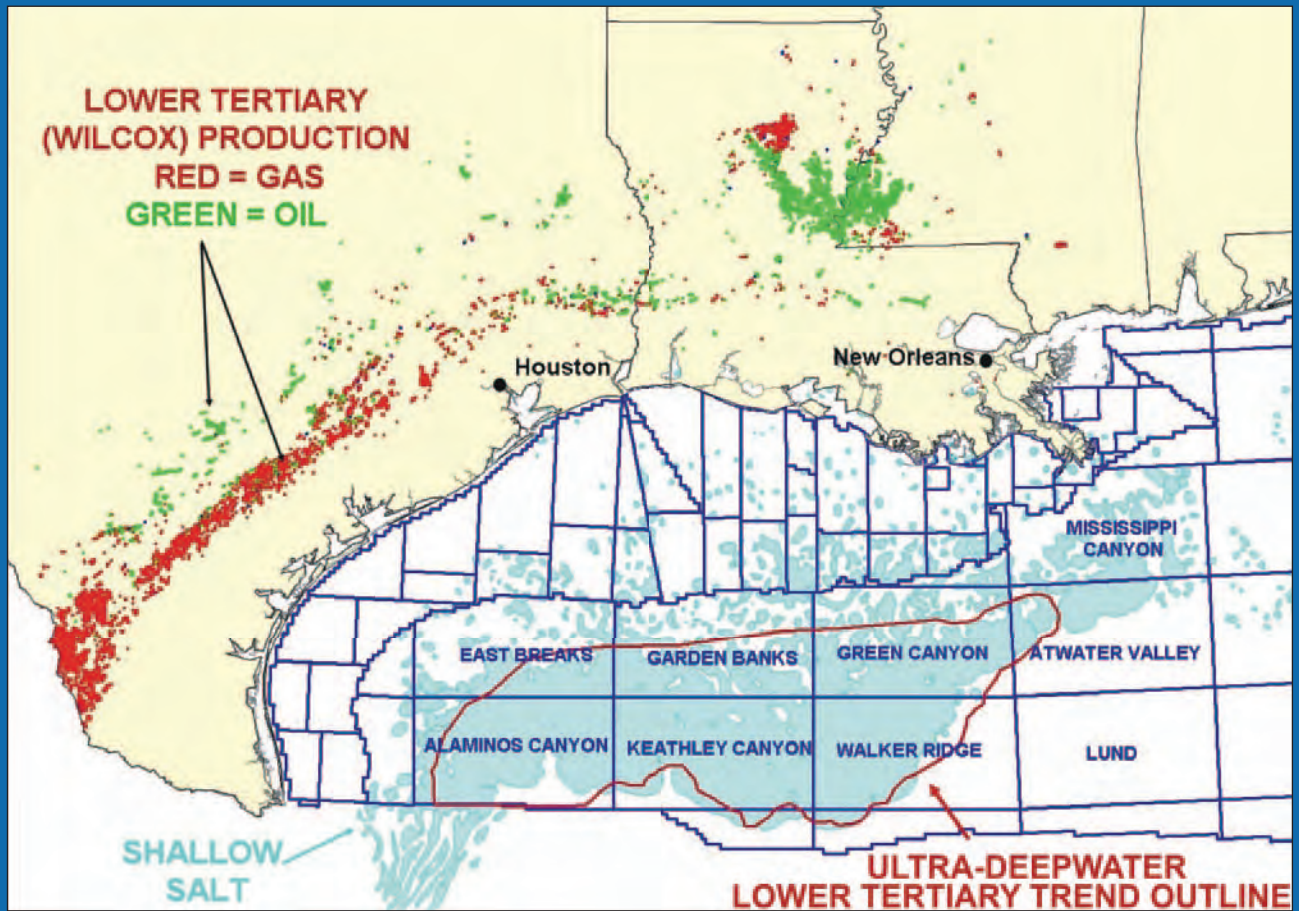


Figure 1. Location of the Lower Tertiary Trend in the Gulf of Mexico. The onshore production of the Lower Tertiary is from shallow-water sands while the offshore discoveries are in sands deposited in deep waters.

THE LOWER TERTIARY TREND

Gulf of Mexico's Emerging Ultra-Deepwater Trend with Potential Resources of 15,000,000,000 Barrels of Oil

15,000,000,000

No matter how you look at it, that is a lot of zeroes. That is what the oil and gas industry estimates that the Lower Tertiary Trend in the ultra-deepwater (>5,000 feet) of the Gulf of Mexico (GOM) may contain. The trend stretches about 300 miles across the GOM some 150 miles offshore (Figure 1). With 12 announced discoveries since 2001 and first production expected in 2009, the Lower Tertiary Trend promises to be active for decades to come.

A few terms should be explained to establish a basis of understanding. A trend is an interval defined by a certain period of time; in this case, the Lower Tertiary Trend was deposited between 24 and 65

million years ago. The trend is composed of various types of plays, which are productive intervals related by common characteristics, such as hydrocarbon trapping mechanisms. Each play contains one or more prospects, which are expected hydrocarbon accumulations separated by topographic lows.

The Lower Tertiary Trend has been producing gas and oil from sands onshore in Texas and Louisiana for decades; no production from the Lower Tertiary has occurred in the GOM. Recent drilling in water depths between 5,000 and 10,000 feet is targeting the downdip extension of the Lower Tertiary sands that were deposited in deep water, some 250 miles from the onshore production.

A Play Develops

Geologists have long known that the prolific onshore producing sands deposited in shallow marine water during Lower Tertiary times may have extended downdip into deeper waters. The problems were to locate these sands, identify traps that would accumulate the hydrocarbons, and determine if the oil was producible (Figure 2).

The first hints of the emergence of the Lower Tertiary Trend came with the drilling of Shell's BAHA prospect in Alaminos Canyon (AC) 600 in 1996. The well was drilled in a record-setting 7,620 feet of water. While it only encountered minor amounts of oil in the upper section of the play, it proved the presence of hydrocarbons in the

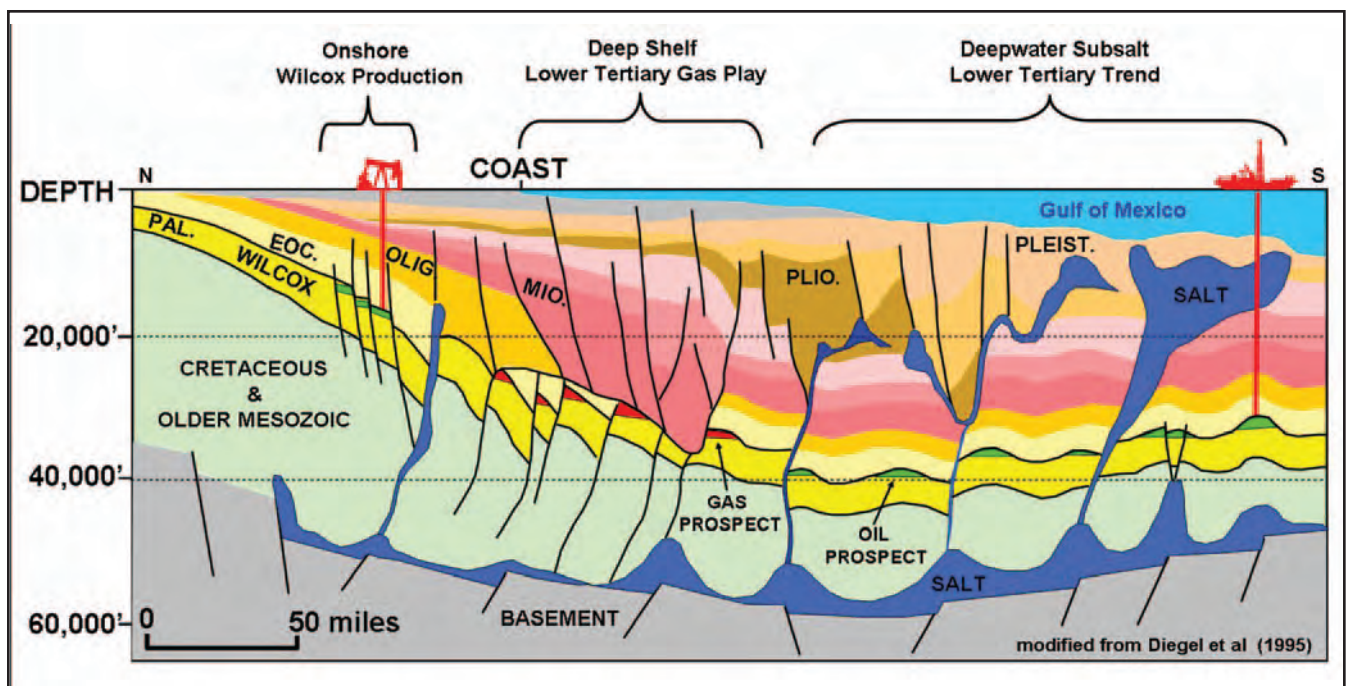


Figure 2. A generalized schematic of the relationship of the Lower Tertiary Trend (Oligocene, Eocene, Paleocene) sediments from onshore to deepwater offshore.

Table 1. Publicly Announced Lower Tertiary Trend Discoveries

Prospect	Block*	Operator	Discovery Date	Hydrocarbons (feet)
Trident	AC 903	Chevron	2001	300+
Great	AC 857	Shell	2002	NA
Cascade	WR 206	BHP	2002	450
Chinook	WR 469	BHP	2003	250
St. Malo	WR 678	Chevron	2003	450+
Tobago	AC 859	Chevron	2004	50
Silvertip	AC 815	Chevron	2004	NA
Tiger	AC 818	Chevron	2004	NA
Jack	WR 759	Chevron	2004	350+
Stones	WR 508	BP	2005	NA
Gotcha	AC 856	Total	2006	290
Kaskida	KC 292	BP	2006	800

* AC = Alaminos Canyon • WR = Walker Ridge • KC =Keathley Canyon

trend. Drilling of the adjacent AC 557 in early 2001 indicated that the Lower Tertiary sediments were unexpectedly thick and had sands of possible reservoir quality.

Unocal, now Chevron, drilled the Trident (AC 903) prospect in the same play in the summer of 2001 and had a major discovery

of 300+ feet of oil in the Lower Tertiary section. Moreover, the well was drilled in 9,743 feet of water in about 65 days at a cost of \$34 million. Shell extended the play with its announcement of a discovery at the Great White prospect (AC 857) in 2002. However, the economic viability of the trend remained

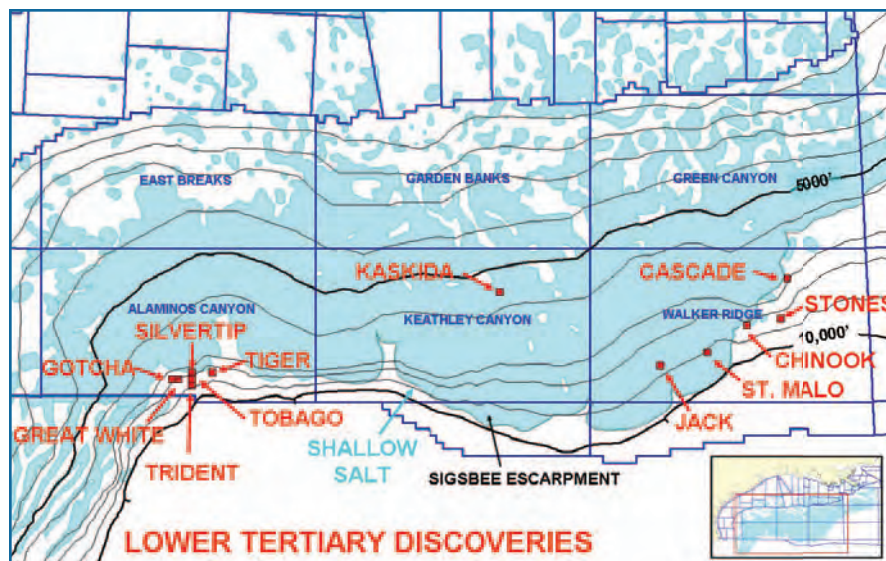


Figure 3. Location of the announced discoveries of the Lower Tertiary Trend in the Gulf of Mexico. The first discoveries were south of the Sigsbee Escarpment. Later discoveries were beneath a layer of horizontal salt.

uncertain, pending confirmation of sustainable commercial oil flow rates.

The BAHA, Trident, and Great White prospects were drilled on large structures seaward of a steep slope called the Sigsbee Escarpment. The Sigsbee Escarpment is a topographic feature formed at the southern extent of a massive horizontal salt layer. A major challenge was to determine the extent of the play to the north under a salt mass that could be miles thick. Geophysicists would have to overcome difficulties imaging structures below the salt layer to locate the traps that contained the oil. Other prospects south of the salt mass were drilled with varying success from 2002 through 2004.

Lower Tertiary Trend Status

This year, the industry reported great strides in the development of the plays within the Lower Tertiary Trend. Announced discoveries reached an even dozen (Figure 3) when BP announced the Kaskida prospect in Keathley Canyon (KC) 292 was a discovery. The Kaskida prospect reached total depth of 32,500 feet in May 2006. BP announced that the well had over 800 feet of hydrocarbon-bearing sands (Table 1). The well drilled through salt to test the deeper traps, indicating that at least in some areas imaging below salt can be accomplished. This subsalt discovery not only established the presence of hydrocarbons in Keathley Canyon for the first time, but indicated that the Lower Tertiary Trend extended from Alaminos Canyon through Keathley Canyon and into Walker Ridge.

Chevron conducted a successful flow test on their Jack prospect #2 well earlier in 2006. Many technological hurdles had to be overcome to test the well on Walker Ridge (WR) 758 in 7,000 feet of water. Chevron flow-tested only 40 percent of the announced 350 feet of oil, but was able to produce at a rate of 6,000 barrels a day. The Jack

well test indicated that the Lower Tertiary Trend can produce oil at a high rate to justify the billions of dollars that need to be invested to bring the oil to market.

Recently, Shell stated plans to develop the Great White, Silvertip, and Tobago prospects in Alaminos Canyon with the Perdido Regional Development host, a spar production facility. The facility will be moored on AC 857 in 8,000 feet of water and will handle drilling through transportation of the hydrocarbons produced from the prospects. The facility will be able to process 130,000 barrels a day, and Shell anticipates first production in 2010. Meanwhile, on the eastern end of the trend in Walker Ridge, Petrobras America and Devon announced their plans to install the first FPSO (floating production, storage, and offloading) in the Gulf to develop the Cascade prospect. Petrobras wants to install another FPSO on the Chinook prospect in the same area. This facility will allow first production to start in late 2009.

Interest in the Lower Tertiary Trend escalated with the announcement of the successful test of the Jack prospect. Western Gulf of

The future development of the Lower Tertiary Trend looks very bright. Exploration companies have targeted dozens of potential prospects for future drilling.



Mexico Sale 200, held in August 2006, generated competitive bidding on the available blocks in the trend. Companies' high bids exceeded \$207 million on 147 blocks that had a Lower Tertiary potential. The two blocks receiving the highest bids (\$21,011,812 for KC 58 and \$12,800,111 for KC 59) are in the Lower Tertiary Trend.

In the Near Future

The future development of the Lower Tertiary Trend looks very bright. Exploration companies have targeted dozens of potential prospects for future drilling. Blocks in the Lower Tertiary Trend whose

leases soon expire will continue to offer the opportunity for competitive bidding in upcoming lease sales. Current high costs associated with the exploration, production, and transportation of oil from water depths upwards to 10,000 feet from rocks 35,000 feet below the surface will be reduced as the technological problems are resolved and an infrastructure is built. The knowledge gained in bringing the Lower Tertiary Trend oil to market will allow the industry to explore in other frontier regions of the world.

A potential of 15 billion barrels of oil in a trend that had its first major discovery a little more than 5 years ago indicates the start of something great.

LOWER TERTIARY FACTS

- ◆ Western Gulf of Mexico Sale 200, August 2006
 - 38% of tracts receiving bids had a Lower Tertiary potential target
 - 63% of the high bids in the sale were on those Lower Tertiary tracts
- ◆ World water depth (10,011 feet) record for a well was a Lower Tertiary Trend test (Toledo Prospect in AC 951)
- ◆ The recently announced discovery Kaskida prospect (KC 292) encountered 800 feet of net oil and is the third deepest well in the Gulf of Mexico.

FOR MORE INFORMATION:

Lower Tertiary Play

Website: www.gomr.mms.gov/homepg/whatsnew/newsreal/2006/061010.pdf

Jack Test Results

Website: www.upstreamreview.com/GoM-bonanza.html

Kaskida Prospect Discovery

Website: www.upstreamreview.com/Kaskida-discovery.html

STABLE AND THRIVING COMMUNITIES

The Flower Garden Banks Long-Term Monitoring program, which began in 1988 and is administered by Minerals Management Service (MMS) and its agency and academic partners in the Gulf of Mexico (GOM), studies the environmentally sensitive coral reefs on the Outer Continental Shelf (OCS), approximately 100 nautical miles southeast of Galveston, Texas.

The East and West Flower Garden Banks are the northernmost coral reefs on the OCS of North America. They are built on outcrops of rock formations, which are overlain with skeletons of corals, coralline algae, and invertebrates of tropical fish species. Twenty-eight species of reef-building corals and 177 species of tropical Atlantic fish make up this biologically sensitive and diverse community.

Since 1973, a No Activity Zone (NAZ) has been in place around each bank to protect the banks from “potential toxic and smothering effects from drilling muds and cuttings discharges.” The MMS monitors the reefs yearly to detect and document any changes caused by oil and gas activities in the region. The designation of the Banks as a National Marine Sanctuary in 1992 has provided additional legislative protection to the area.

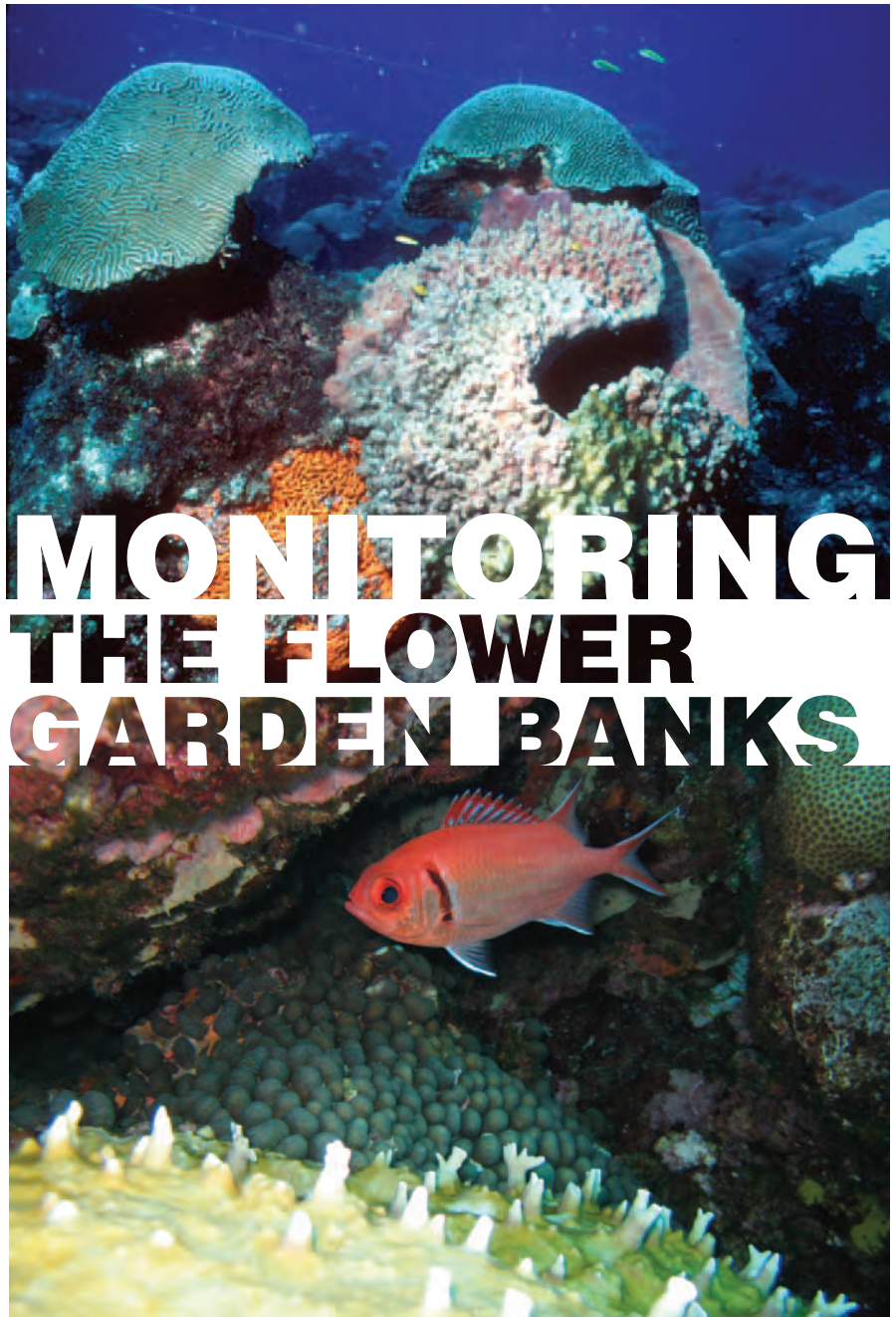
In 2005, scientists observed an outbreak of what may be a condition called “white plague” on the reef. The disease was more widespread than in previously observed outbreaks, but appears to have slowed or become dormant. Scientists continue to monitor the situation to identify the disease and its possible effects on the Flower Garden Banks definitively.

Bleaching of up to 40 percent of the community has also been observed, as well as damage from hurricanes, notably Hurricane Rita. These events have been reported by

long-term monitoring equipment, as well as direct observation from recreational divers and follow up by marine scientists.

To date, long-term monitoring of the Banks has indicated continued stability and continuing growth for the communities. Fish populations continue to be healthy, while the

sea urchin populations remain manageable. Overall, monitoring of the reefs has revealed a thriving and diverse community. Environmental and marine scientists at MMS will continue to monitor this remarkable marine resource to ensure it will remain undisturbed by the quest for energy resources in the GOM.



COOPERATIVE CONSERVATION CREATES SHARED RESOURCES



As oil and gas exploration intensifies and moves deeper into the Gulf of Mexico (GOM), concerns arise about the possible effects on marine life in general and cetaceans in particular. A great deal of study has been directed towards ensuring that oil spills from exploration and development are eliminated, or at least greatly reduced. Of special interest is how noise from seismic surveys may affect sperm whales (*Physeter macrocephalus*) in the northern GOM. Texas A&M University is working with the Minerals Management Service (MMS) under a Cooperative Agreement to study this important question.

Planning of the Sperm Whale Seismic Study (SWSS) began in 1999, while the study itself began in 2002. Interagency cooperation was vital to this project. Support from the Industry Research Funders Coalition (IRFC), Office of Naval Research (ONR), National Science Foundation (NSF), and the National Fish and Wildlife Federation (NFWF) helped guide the success of the program. In addition, the International Association of Geophysical Contractors (IAGC) and IRFC offered seismic source vessels to serve as the “noise” in the studies. This cooperation is a prime example of cooperative conservation – an effort to bring the knowledge and assets of many agencies and individuals to bear on the questions and problems affecting our natural resources.

An international team of scientists conducted SWSS cruises in the northern GOM. Research topics included

- ▶ long-term movements of sperm whales by using radio telemetry tags, called S-tags;
- ▶ short-term movements of sperm whales by using digital recording acoustic tags, called D-tags;
- ▶ sperm whale reactions to controlled bursts from seismic airguns;
- ▶ analyses of genetic markers of the GOM population to determine the sex of the animals and their genetic relatedness to each other and to North Atlantic populations; and
- ▶ characterization of sperm whale habitats.

In addition to the telemetric and acoustic information, visual and passive acoustic observations were recorded and photos were taken of the flukes (tails) of each whale for identification.

Although the results are preliminary, some conclusions can be made from the study. One surprising finding is that groups of sperm whales in the northern Gulf are smaller in size and in number than groups in other parts of the Atlantic. The groups, composed largely of females, also tend to stick close to their “home” area with little, if any, long distance travel. When exposed to the short-term airgun noise, the whales did not show the avoidance behavior (diving or swimming away)

Sperm Whale Facts

- Sperm whales have teeth, each weighing about two pounds.
- They have huge brains that weigh around 20 pounds.
- Adult males grow to about 50-60 feet long and weigh 40-50 tons.
- Females grow to about 33-40 feet long and weigh 14-18 tons.
- A whale heart can weigh as much as 277 pounds.
- Sperm whales can dive as deep as 3,500 feet and stay submerged up to an hour.
- Sperm whales can live to be 50-70 years of age.

Source: American Cetacean Society
www.acsonline.org/factpack/spermwhl.htm

that some experts had expected, suggesting that whales in this area of the GOM may have become acclimated to certain noise levels.

The SWSS program has combined cutting-edge technology with internationally acknowledged research to gain knowledge of the behavior of endangered sperm whales. The multifaceted study design, and the ongoing synthesis of data from a variety of perspectives, is giving researchers and regulators the information needed to ensure the protection of this endangered species. Technical innovations have led to numerous new equipment and instrument designs that will not only benefit the SWSS project but also other research around the globe.

FOR MORE INFORMATION:

Sperm Whale Seismic Study in the GOM

Website: www.gomr.mms.gov/homepg/regulate/environ/studies/2006/2006-034.pdf

Website: www.gomr.mms.gov/homepg/regulate/environ/mamam/sperm_research.html

Website: <http://seawater.tamu.edu/SWSS/>

COLD WATER CLEANUP RESEARCH PRODUCES NEW TECHNIQUES

Cleaning up oil spills in the relative warmth of the Gulf of Mexico (GOM) is a challenge, but cleaning up oil spills in subzero temperatures, where all or part of a spill lies beneath an ice flow or is interspersed with broken ice, is even more difficult. The Minerals Management Service (MMS) is funding Cold Water Oil Spill Response Research to improve its knowledge of cold water oil spills and the techniques and technologies used in the “detection, containment, and clean up of oil spills” that may occur on the Outer Continental Shelf (OCS).

New research and development projects are showing promise in dealing with spills in three distinct conditions:

- spills in open water
- spills in freezeup or breakup conditions
- spills with total ice coverage

Spills will also occur in distinct areas:

- on top of or beneath solid ice
- on stable ice extending from the shore (land-fast)
- on drifting ice floes (pack ice)
- on ice-covered shorelines

The complex task of spotting oil spills under ice or snow has taken a step forward with promising new experiments using ground-penetrating radar (GPR) and ultra-

The MMS is committed to the continuing study of cold water spills.

sensitive ethane sensors. In a 2006 experiment, an oil spill was detected under land-fast ice by using this technique. The spill was observed, and when the oil had migrated to the surface, an in-situ burn removed more than 96 percent of the spill. This promising technique can use current radar technology with few major modifications. The MMS has funded further research on GPR to locate spills in and under ice in 2007.

Another promising mechanical recovery technique in broken ice involves using a skimmer, in which the surface of the recovery unit drum was replaced with one using a patterned polymeric material; by doing so, the skimming efficiency was increased by 200 percent. Additional research experiments will be conducted in February-March

2007 at the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire.

Research experiments on the effectiveness of dispersants on Alaskan crude oils in very cold water have been conducted at Ohmsett – The National Oil Spill Response Test Facility in Leonardo, New Jersey. Research results demonstrate that dispersants are effective on these crude oils. Additional dispersant research experiments with Alaskan crude oils in very cold water will be conducted in January-February 2007 at Ohmsett. New oil-herding surfactants, which thicken an oil slick so that the oil can be burned away, are being tested. Successful full-scale chemical herder experiments were conducted November 2-7, 2006, at the BP Fire Training in Prudhoe Bay, Alaska.

The MMS is committed to the continuing study of cold water spills. As more is learned about the behavior of oil in cold water and ice, and effective new technologies are developed, the danger to the environment from now rare oil spills will be greatly reduced.



A disc skimmer deployed by Alaska Clean Seas personnel during a training exercise at Prudhoe Bay, Alaska.

FOR MORE INFORMATION:

Cold Water Oil Spill Cleanup Methods

Website: www.mms.gov/tarprojects/573.htm

Website: www.mms.gov/tarprojects/554.htm

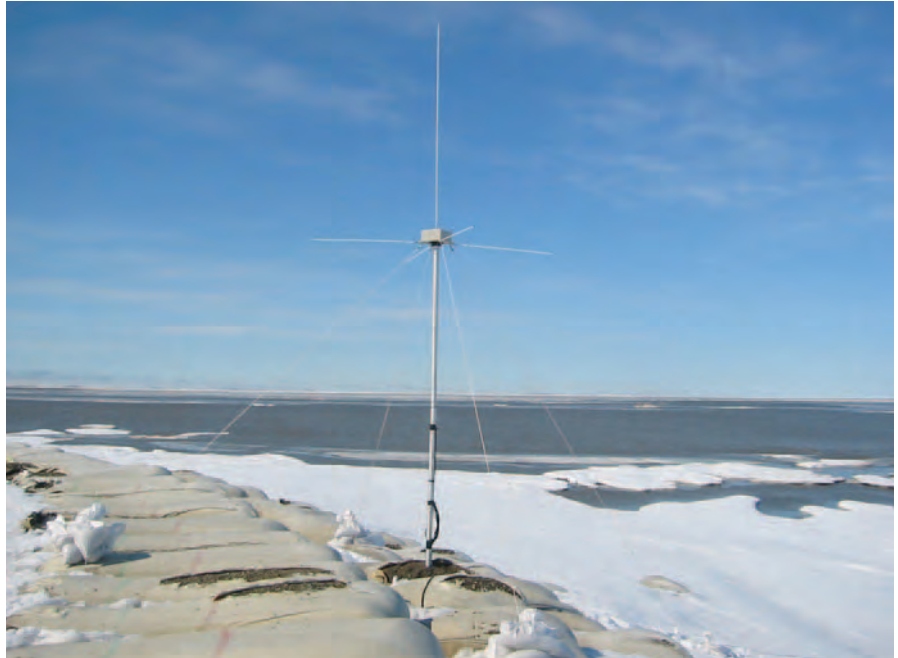
Website: www.mms.gov/tarprojects/547.htm

HIGH-FREQUENCY RADAR (CODAR) TESTS OFFER NEW UNDERSTANDING

Coastal Ocean Dynamics Applications Radar (CODAR) high-frequency radar units have been set up in selected regions of Alaska for specified test periods, as a potential first step towards incorporating these systems into a regional observation system in the Alaskan OCS Region. The radars were first deployed along the coast of the Beaufort Sea from June through October 2005 and 2006. The units were then redeployed in the lower Cook Inlet in November 2006 and will remain there through November 2007. CODAR collects surface current data on an hourly basis, and sends the data to the project web site at the University of Alaska, Fairbanks (see below). The radar can map high-resolution surface currents out to approximately 70 kilometers from shore.

CODAR has been successfully used to measure regional-scale surface currents along the east and west coasts of the United States in open water conditions where sea ice is not present. CODAR was deployed in the Beaufort Sea, Alaska, where the presence of sea ice makes it extremely difficult to collect surface current data by using conventional equipment. Sea ice covers the Beaufort Sea study area from the end of October through the end of June. Beginning in June, the sea ice begins to melt and small pockets of open water appear. During July, August, and September, as temperatures increase, sea ice continues to melt and larger areas of open water are present. Beginning in October, sea ice begins to form along the shore (shore-fast ice) and spreads seaward until the study area is completely covered with ice by the end of October.

The Beaufort Sea field project tested the radar's capability to collect surface current data as sea ice conditions changed from July through October. High-frequency



CODAR receiving antenna at the Endicott Oil facility along the Beaufort Sea coastline.

radar was successful in the collection of surface current data throughout the sea ice breakup and freezeup periods. Some of the preliminary results display significant variability in seasonal patterns of nearshore surface currents, and provided the Minerals Management Service (MMS) with the capability to map nearshore circulation patterns not identified in previous regional circulation models.

This radar "picture" provides important detailed information, such as baseline oceanographic information, to scientists and industry. For environmental scientists, it will be useful for comparative hydrodynamics and

circulation models for oil-spill risk analysis. Workers in the oil and gas industry and shipping and fishing industries may eventually benefit from more detailed charts of surface current conditions for the area.

The MMS Alaska Office and the Alaska Offshore Observing System are part of a nationwide collaboration of regional associations to build an Integrated Ocean Observation System (IOOS). This will provide detailed information about climate, marine ecosystems, and natural hazards to improve the safety of marine operations, reduce public health risks, enhance national security, and preserve marine ecosystems.

FOR MORE INFORMATION:

The SALMON Project

Website: www.ims.uaf.edu/salmon/

CODAR in Alaska

Website: www.mms.gov/alaska/reports/2006rpts/2006_032.pdf

Website: www.mms.gov/alaska/reports/2006rpts/2006_031.pdf

Website: www.codaros.com/

MMS – A Leader in Securing the Nation's Domestic Energy Supply

NEW WAVES

Late-breaking News & Information



Flame scallop in the East Flower Garden Banks. Photo by James Sinclair

MMS Releases New Report on Flower Garden Banks

The Leasing and Environment Office, Gulf of Mexico OCS Region, announces the availability of a new study report, *Long-Term Monitoring at the East and West Flower Garden Banks National Marine Sanctuary, 2002-2003* (OCS Study MMS 2006-035).

The Minerals Management Service (MMS), concerned with potential long-term impacts of oil and gas activity in the Gulf of Mexico on coral reef systems, developed a monitoring program in 1974 of the East and West Flower Garden Banks (FGB). Both features lie approximately 100 miles southeast of Galveston, Texas, and are the northernmost coral reefs on the continental shelf of North America.

With oil and gas activity in the area since the 1970's, MMS quickly established itself as a major participant in developing an ongoing involvement and stewardship of the two coral reef systems. In 1974, MMS began using a comprehensive outline and mapping program to conduct studies and compile information, thereby ensuring the integrity of the FGB's.

Quantitative surveys began in 1988, and when the East and West Flower Garden Banks were designated as a United States National Marine Sanctuary in 1992, MMS expanded its stewardship. The MMS and the National Oceanic and Atmospheric Administration (NOAA) co-funded annual monitoring of the FGB beginning in 1996. This long-term monitoring program assesses the health of the coral reefs, evaluates changes, and examines water quality and fish population dynamics. A variety of monitoring methods has provided a database of descriptive information and increased knowledge of the surrounding environment, as well as provided information for resource management decisions.

Analysis of the results of recent studies (2002-2003) indicated no significant long-term changes in coral reef populations, cover, or diversity. At present, the report may be downloaded from the MMS website through the Environmental Studies Program Information System (ESPIS) at www.gomr.mms.gov/homepg/espis/espisfront.asp.

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