OCS Report
MMS 2009-016

Deepwater Gulf of Mexico 2009: Interim Report of 2008 Highlights

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

ON COVER—Located 150 miles (241 kilometers) southeast of New Orleans in Mississippi Canyon Block 778 in a water depth of approximately 6,050 feet (1,844 meters), the Thunder Horse platform is the world's largest semisubmersible facility. British Petroleum received approval from the Minerals Management Service to debottleneck the topside production facilities to 275,000 barrels of oil and 220 million standard cubic feet of natural gas per day. As of March 20, 2009, production was approximately 260,000 barrels of oil and 210.5 million standard cubic feet of natural gas per day from seven wells. The Thunder Horse Field is the largest producer in the Gulf of Mexico. (Image courtesy of BP America Inc.)

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ABBREVIATIONS AND ACRONYMS

2D	two dimensional
3D	three dimensional
AC	Alaminos Canyon
APD	Application for Permit to Drill
API	American Petroleum Institute
APM	Application for Permit to Modify
AT	Atwater Valley
AVO	amplitude variation with offset
bbl	barrels
BBOE	billion barrels of oil equivalent
Bcf	billion cubic feet
Bcf/d	billion cubic feet per day
BOE	barrels of oil equivalent
BOE/d	barrels of oil equivalent per day
bo/d	barrels of oil per day
bw/d	barrels of water per day
cf/d	cubic feet per day
CID	Conservation Information Document
cm/s	centimeters per second
CPA	Central Planning Area
CSA	Continental Shelf Associates
CZM	coastal zone management
DC	DeSoto Canyon
° C	degrees Celsius
° F	degrees Fahrenheit
DOCD	Development Operations Coordination Document
DTS	disconnectable transfer system
DVA	direct vertical access
DWOP	Deep Water Operations Plan
DWRRA	Deep Water Royalty Relief Act
EA	environmental assessment
EB	East Breaks
EIS	environmental impact statement
EP	Exploration Plan
ESP	electric submersible pump
EW	Ewing Bank
FPS	floating production system
FPSO	floating production, storage, and offloading
FPU	floating production unit
FR	*Federal Register*
ft	feet
ft/s	feet per second
GB	Garden Banks
GC	Green Canyon
GGS	Global Geo Services ASA
GOM	Gulf of Mexico
IAD	industry-announced discovery
KC	Keathley Canyon
km	kilometers
km^2	square kilometers
LL	Lloyd Ridge
m	meters
MC	Mississippi Canyon
Mcf	thousand cubic feet
mi	miles
mi^2	square miles
MMbbl	million barrels
MMcf/d	million cubic feet per day
MMS	Minerals Management Service
MODU	mobile offshore drilling unit
MTLP	mini-tension-leg platform
N	north
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NTL	Notice to Lessees and Operators
NW	northwest
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OSTS	Office of Structural and Technical Support
PEA	programmatic environmental assessment
psi	pounds per square inch
RP	recommended practice
SAIC	Science Applications International Corporation
SE	southeast
SWSS	Sperm Whale Seismic Study
TGS	TGS-NOPEC Geophysical Company ASA
TLP	tension-leg platform
U.S.	United States
USDOI	United States Department of the Interior
USGS	United States Geological Survey
WP	well protector
WR	Walker Ridge

PREFACE

This is the ninth publication that the Minerals Management Service has released chronicling deepwater exploration, development, and production activities in the Gulf of Mexico. For this report, deep water is considered to be water depths of 1,000 feet (305 meters) or greater.

Leasing activity in the deepwater Gulf remains strong. Central Sale 206, held on March 19, 2008, attracted approximately $3.7 billion in high bids—the most since Federal offshore leasing began in 1954. The Minerals Management Service received 1,057 bids from 85 companies on 615 blocks, of which 603 were ultimately awarded. Sixty-nine percent of all blocks receiving bids were in 1,000 feet (305 meters) of water or greater. Occurring on the same day as Sale 206, Eastern Sale 224 garnered over $65 million in high bids, attracting 58 bids from six companies on 36 blocks, of which all were ultimately awarded. All acreage offered was in water depths greater than 2,625 feet (800 meters). Western Sale 207, held on August 20, 2008, attracted approximately $487 million in high bids. The Minerals Management Service received 423 bids from 53 companies on 319 blocks, of which 313 were ultimately awarded. Seventy-eight percent of all blocks receiving bids were in 1,000 feet (305 meters) of water or greater. Central Sale 208, held on March 18, 2009, attracted approximately $703 million in high bids. The Minerals Management Service received 476 bids from 70 companies on 348 blocks. Seventy-two percent of all blocks receiving bids were in 1,000 feet (305 meters) of water or greater.

There were 15 industry-announced discoveries in 2008, almost double the number of discoveries in 2007. Deep water has continued to be a very important part of the total Gulf production, providing approximately 70 percent of the oil and 36 percent of the gas in the region. At the end of 2008, there were 141 producing projects in the deepwater Gulf, up from 130 at the end of 2007. The 20 highest producing blocks in the Gulf continue to be located in deep water. Seven deepwater projects, including Thunder Horse, began production last year. The Thunder Horse Field is now the largest producer in the Gulf, with production of approximately 260,000 barrels of oil per day.

The first floating production, storage, and offloading facility in the U.S. Gulf, the *BW Pioneer* vessel, will develop the Cascade and Chinook Fields in Walker Ridge, with first oil production expected in 2010. This development project will utilize four technologies considered new to the Gulf, including free-standing hybrid risers, polyester mooring, electric submersible booster pumps, and shuttle tankers for oil export. Another first for the Gulf will be the use of a ship-shape, floating production unit, the *Helix Producer I* vessel, for the Phoenix development in Green Canyon, with a planned production startup in 2010. A disconnectable transfer system will be used to connect the subsea wells to the *Helix Producer I*, also a first for the U.S. Gulf. Also scheduled to begin production in 2010 are the projects tied back to the Perdido Regional Host facility in Alaminos Canyon. The truss spar was installed in over 8,000 feet (2,438 meters) of water in August 2008 and sets a record for the deepest spar in the world. Perdido is the first application of full, host-scale subsea separation and boosting in the U.S. Gulf.

The Minerals Management Service is a responsible steward of U.S. offshore resources by ensuring the receipt of fair market value for the sale of leases, encouraging conservation, evaluating and approving new technology, and regulating drilling and production.

Lars Herbst
Regional Director
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INTRODUCTION

The Deepwater Gulf of Mexico 2009 report is a condensed and updated edition of the biennial deepwater report published by the Minerals Management Service (MMS) (Richardson et al., 2008). The 2009 report provides an up-to-date review of activities in the deepwater U.S. Gulf of Mexico (GOM), including highlights from 2008. All statistics in this report are gleaned from data as of the end of December 2008, except production volumes and rates, which were compiled through the end of December 2007 (the most recent calendar year of complete production data available at the time of this publication).

The deepwater GOM is an integral part of the Nation's oil and gas supply and one of the world's most important oil and gas provinces. Numerous highlights this past year include (1) the record-setting Lease Sale 206, which attracted $3.7 billion in high bids—the most since Federal offshore leasing began in 1954, (2) exploratory drilling that resulted in 15 new discoveries, and (3) the number of producing projects in the deepwater GOM at the end of 2008 was 141, up from 130 at the end of 2007.

Detailed statistics and discussions of these and other highlights are presented in this report, which is divided into six sections.

The **What's New** section includes:

- Discoveries in 2008
- Production startups
- New acreage available for the first time in 20 years
- New 5-Year OCS Oil and Gas Leasing Program
- Increase in royalty and rental rates
- Sale boundary changes

The **Background** section includes:

- Definition of key terms
- Ultra-deepwater drilling and discoveries
- Deepwater discoveries by year
- Proved field sizes
- Hub facilities

The **Leasing and Environment** section includes:

- Information on the 5-Year OCS Oil and Gas Leasing Program
- Leasing activities and trends
- Sales 206, 224, 207, and 208 statistics
- Future leasing activities, including anticipated lease expirations
- Grid programmatic environmental assessments
- Recent MMS environmental studies

The **Drilling and Development** section includes:

- Hurricane safety-related Notices to Lessees and Operators (NTL's)
- Information on operational plans
- Statistics on GOM and worldwide rig availability
- Deepwater drilling activities
- Deepwater development systems
- New GOM technologies and deepwater developments

The **Reserves and Production** section includes:

- Historical deepwater reserve additions
- Deepwater projects online between 2007 and 2013
- Information on the top 20 producing blocks
- Shallow-water and deepwater production comparison
- High deepwater production rates

The **Highlights and Conclusions** section includes:

- Highlights from 2008 and early 2009
- Lease acquisition to production lag times

WHAT'S NEW

EXPLORATION ACTIVITY

Exploratory drilling in the deepwater GOM has found more than 6.6 billion barrels of oil equivalent (BBOE) since 2002, more than double the amount reported in the 2005 Deepwater Interim Report (French et al., 2005). Exploration efforts in 2008 have resulted in 15 new deepwater discoveries (**Table 1**). Industry comments on many of these discoveries are shown in **Table 2**. Five of these discoveries were drilled in water depths greater than 5,000 feet (ft) [1,524 meters (m)] (**Figure 1**).

Table 1. Deepwater Discoveries for 2008

Prospect Name	Area/Block	Water Depth (ft)	Operator
Diamond	LL 370	9,975	Murphy
Hal	WR 848	7,657	Statoil/ExxonMobil
Tortuga	MC 561	6,302	Noble Energy
Freedom	MC 948	6,095	British Petroleum/Noble Energy
Dalmatian	DC 48	5,876	Murphy
Kodiak	MC 771	4,986	British Petroleum
(unnamed)	GC 448	3,266	LLOG
Gladden	MC 800	3,116	Newfield Exploration
(unnamed)	MC 503	3,099	LLOG
Geauxpher	GB 462	2,820	Mariner Energy
Anduin West	MC 754	2,696	Newfield Exploration
Sargent	GB 339	2,180	Deep Gulf Energy
(unnamed)	MC 72	2,013	LLOG
(unnamed)	VK 821	1,030	Walter Oil & Gas
Shaft	GC 141	1,003	LLOG

Table 2. Industry Comments on 2008 Deepwater Discoveries

Prospect Name	Industry Comments
Diamond	natural gas play was found for sufficient subsea tieback
Hal	subsalt, four-way closure in the Paleogene fold belt play
Tortuga	encountered natural gas in a secondary objective
Freedom	greater than 550 net ft of hydrocarbon-bearing sands
Dalmatian	120 ft measured depth of net high quality natural gas pay
Kodiak	about 500 net ft of hydrocarbon-bearing sands in Middle & Lower Miocene reservoirs
unnamed (GC 448)	over 85 ft of oil-bearing sand
Gladden	80 ft of net oil pay
unnamed (MC 503)	over 380 ft of gas and oil pay zones in four separate reservoir packages
Geauxpher	gross proved and probable reserves of approximately 100 Bcf natural gas equivalent
Anduin West	30 ft of net gas and condensate pay
Sargent	45 ft of net gas pay
unnamed (MC 72)	over 100 ft of gross gas-filled sand
unnamed (VK 821)	will be a one well subsea tieback to infrastructure on an adjacent block

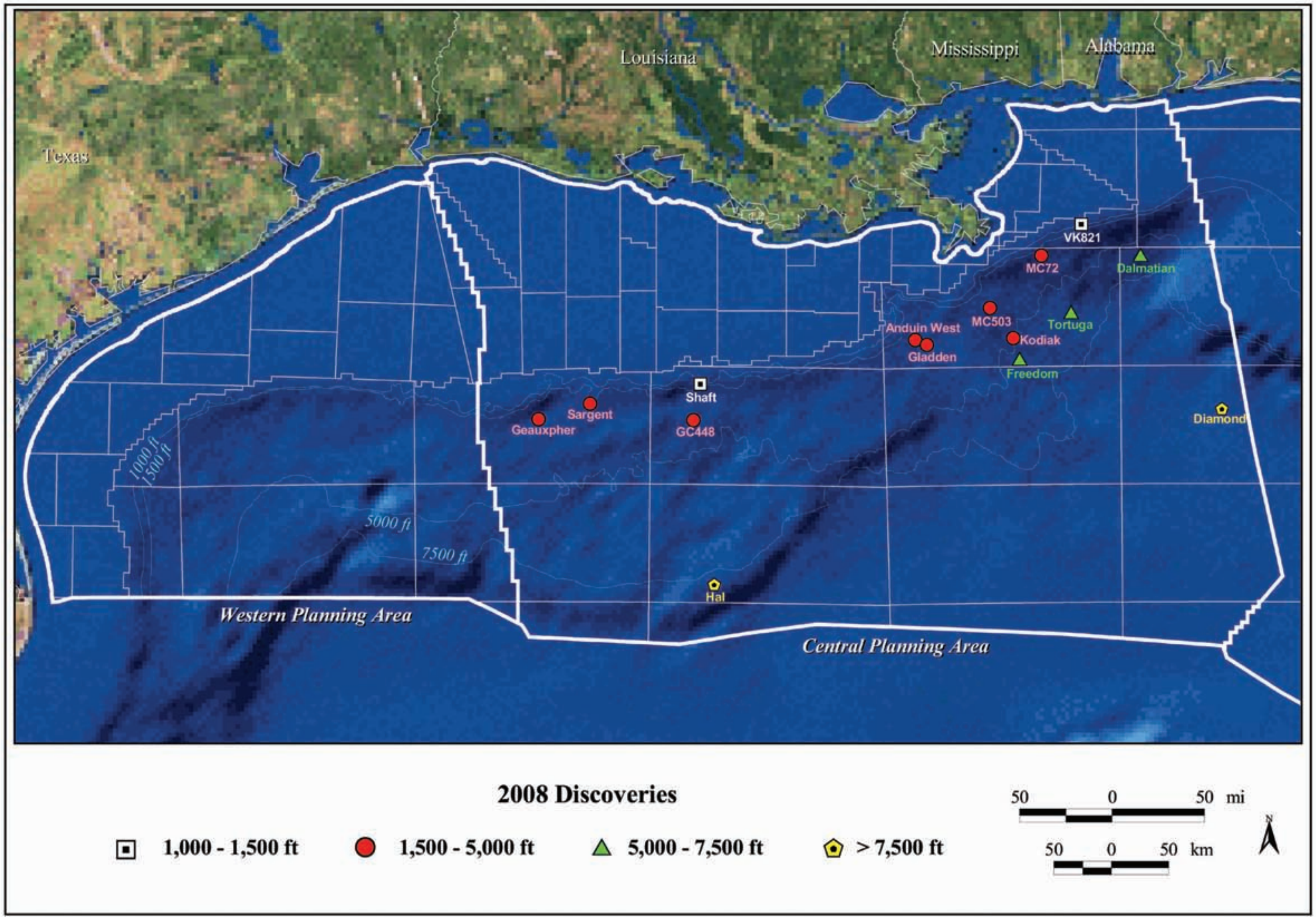


Figure 1. Geographic distribution of 2008 discoveries by water depth.

PRODUCTION STARTUPS

Numerous large deepwater projects have transitioned from an exploratory and appraisal phase into a production phase. For example, in 2007, Atlantis in Green Canyon Block 787 [semisubmersible capacity of 200,000 barrels of oil per day (bo/d) and 180 million cubic feet per day (MMcf/d)] and the fields tied into the Independence Hub production facility in Mississippi Canyon Block 920 [floating production unit (FPU) capacity of 1 billion cubic feet per day (Bcf/d)] came online. This trend continued into 2008 and continues for the near future, with production startups at:

- Thunder Horse in Mississippi Canyon Block 778 (semisubmersible capacity of 275,000 bo/d and 220 MMcf/d) in 2008
- Tahiti in Green Canyon Block 640 (truss spar capacity of 125,000 bo/d and 70 MMcf/d) in 2009
- Thunder Hawk in Mississippi Canyon Block 734 (semisubmersible capacity of 60,000 bo/d and 70 MMcf/d) in 2009
- Thunder Horse North in Mississippi Canyon Block 776 (tied back to the Thunder Horse facility) in 2009
- Cascade and Chinook in Walker Ridge Blocks 206 and 469, respectively, [floating production, storage, and offloading (FPSO) system oil storage capacity of 600,000 barrels, oil processing capacity of 80,000 bo/d, and gas export capacity of 16 MMcf/d] in 2010
- Phoenix in Green Canyon Block 237 (FPU maximum capacity of 45,000 bo/d and 72 MMcf/d) in 2010
- Great White, Silvertip, and Tobago tied into the Perdido Regional Host facility in Alaminos Canyon Block 857 [truss spar capacity of 100,000 bo/d and 200,000 cubic feet per day (cf/d)] in 2010

These projects, among others, represent commitments by industry to overcome the challenges of drilling and development in the deepwater environment of the GOM.

181 AREA AND 181 SOUTH AREA—ACREAGE AVAILABLE FOR THE FIRST TIME IN 20 YEARS

Acreage for lease in Sale 224 (held on March 19, 2008) and Sale 208 (held on March 18, 2009) included areas that have been off-limits to exploration until the most recent 5-Year Leasing Program (2007-2012) implemented by MMS. The Gulf of Mexico Energy Security Act of 2006 mandated that these areas be offered for lease and that the States of Alabama, Louisiana, Mississippi, and Texas share a portion of all qualified revenues from leases in these new areas.

Eastern Sale 224 offered approximately 0.5 million acres from what is known as the 181 Area, and Central Sale 208 offered approximately 4.2 million acres from what is known as the 181 South Area (**Figure 2**). These two sales presented oil companies the first opportunity to lease blocks in these areas since 1988.

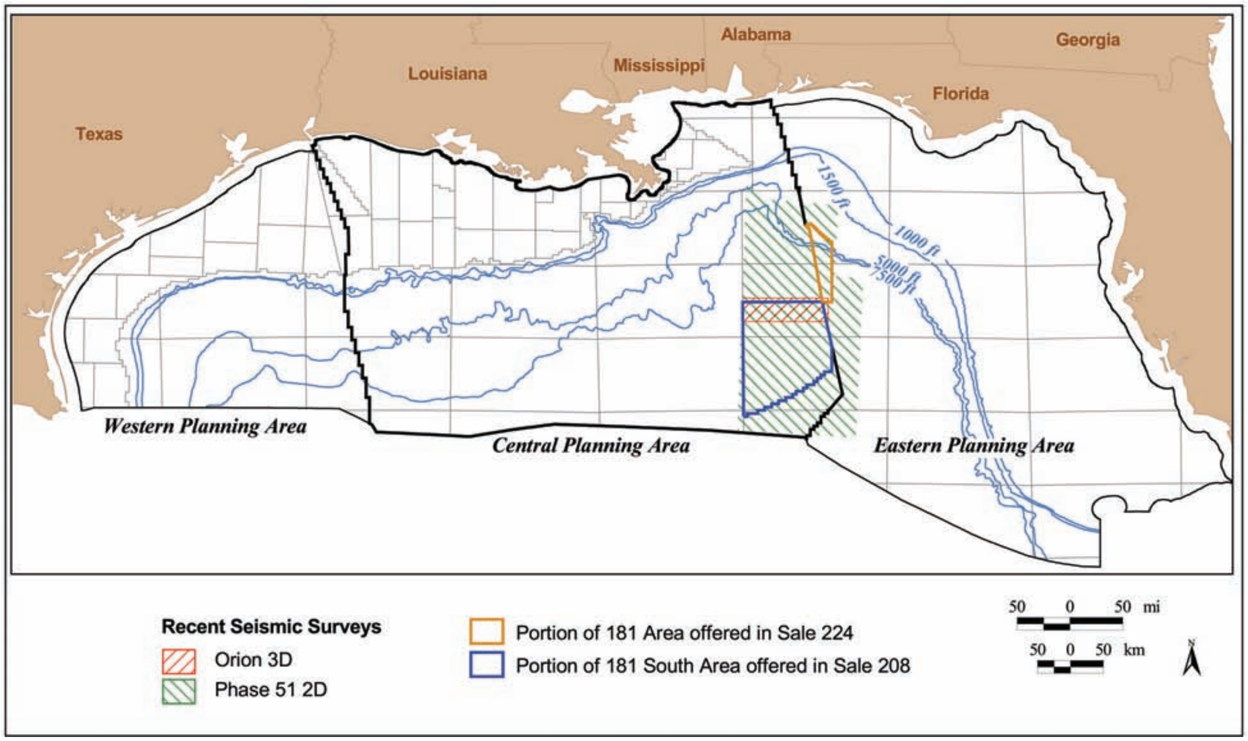


Figure 2. Map of the portion of the 181 Area offered in Sale 224 and the portion of the 181 South Area offered in Sale 208. Also shown are two recent seismic surveys in these areas.

Two recent seismic datasets are available over the 181 and 181 South Areas (**Figure 2**). TGS-NOPEC Geophysical Company ASA (TGS) and Global Geo Services ASA (GGS) entered into a 50-50 joint venture on a 28,000-kilometer (km) [17,398-mile (mi)] multi-client 2D survey, known as Phase 51. The project was supported by pre-funding from several oil companies. TGS and GGS combined acquisition resources to complete the recording of the survey in February 2008. Both pre-stack time and depth migration processing were performed by GGS-Spectrum. TGS is responsible for marketing and sales of the resulting products.

TGS also recently commenced a multi-client 3D survey over the northern 181 South Area. The survey, known as Orion 3D, will cover approximately 175 Outer Continental Shelf (OCS) blocks (4,100 km^2 or 1,583 mi^2) in the Lloyd Ridge area. The exploration potential for this area includes seismic attribute plays as well as deeper structural opportunities. TGS acquired the Orion 3D survey utilizing the Fugro Geo Barents seismic vessel. The data were recorded with 9,000-m (29,528-ft) streamer offsets and were processed with both pre-stack time and pre-stack depth imaging. In addition to the full offset migrations, partial offset stacks were generated for evaluating amplitude variation with offset (AVO). The Orion 3D survey was supported by industry funding.

The Phase 51 2D and Orion 3D programs are located in close proximity to the Independence Hub production facility operated by several independent oil companies. This large facility produces gas from a number of discoveries that have been made in the area including Spiderman, Cheyenne, Jubilee, and Vortex.

NEW 5-YEAR OCS OIL AND GAS LEASING PROGRAM INITIATED

Lease sales are scheduled as part of the 5-Year Program, officially titled "Outer Continental Shelf Oil and Gas Leasing Program." The current program covers the time period from July 2007 through June 2012. Developing a 5-Year Program is a multi-step process incorporating public comment and consultation with states and other Federal agencies. This process usually takes 2 years to complete.

In August 2008, the Interior Department issued a Call for Information and Nominations, the first step in a multi-step process, to begin a new 5-Year Program covering the time period from July 2010 through June 2015. This step included a 45-day comment period, which was extended by 3 days and closed September 18, 2008.

The second step in the process, the issuance of a draft proposed program, took place January 15, 2009. The draft proposed program seeks public comment on all aspects of the new program for 2010-2015 including energy development and economic and environmental issues in the OCS areas.

For the 2010-2015 draft proposed program, MMS proposes 31 OCS lease sales in all or some portion of 12 of the 26 planning areas—4 areas off Alaska, 3 areas off the Atlantic Coast, 3 areas in the GOM, and 2 areas off the Pacific Coast. The draft proposed program is just a starting place designed to encourage discussions about the OCS areas of greatest interest and potential. Any new areas that are included in the final program will not be available for leasing until the 5-Year Program has been completed and approved. No area can be leased without being included in the then current approved 5-Year Program.

In February 2009, the Interior Secretary extended the comment period for the draft proposed program for an additional 180 days to September 21, 2009, in order to provide additional time for input from states, stakeholders, and affected communities. The Secretary also requested that MMS and the United States Geological Survey (USGS) produce a report on the offshore resources and potential impacts by the end of March 2009. Four regional meetings are scheduled, one each for Alaska, the Atlantic Coast, the Gulf Coast, and the Pacific Coast, following publication of the report. More information can be found on MMS's Web site at http://www.mms.gov/offshore/salazarregionalmeetings.htm.

ROYALTY AND RENTAL RATE INCREASES

Lease Sales 206 and 224, held in March 2008, included an increase in the royalty rate for deepwater leases to 18.75 percent from the 16.7 percent rate.

The MMS has increased the rental rates for leases issued in Sale 208, held in March 2009. The increase in the base rental rate raises rates from $6.25 to $7.00 per acre in water depths of less than 200 m (656 ft) and from $9.50 to $11.00 per acre in 200 m (656 ft) or deeper. For the first time, rental rates will be escalated for all leases with initial terms of more than 5 years. Rental rates will also be escalated for leases with an approved extension of the initial lease period. Amounts for each increase and details are listed in the Final Notice of Sale (*Federal Register*, 2009).

CHANGE IN ADMINISTRATIVE BOUNDARIES (SALE BOUNDARIES)

On January 3, 2006, MMS published a notice in the *Federal Register* (2006; 71 FR 1) announcing the setting of Federal OCS offshore administrative boundaries beyond State submerged lands for planning, coordination, and administrative purposes. More information on these administrative boundary changes can be found on MMS's Web site at http://www.mms.gov/ld/AdminBoundaries.htm. The planning area boundary changes took effect with the 2007-2012 5-Year Program on July 1, 2007.

Since then, minor modifications have been implemented to avoid splitting some blocks. These modifications resulted in boundaries that have a "stair-stepped" appearance. These new planning area boundaries will appear on all pertinent maps in this report.

BACKGROUND

Definitions

For purposes of this report, deep water is defined as water depths greater than or equal to 1,000 ft (305 m), and ultra-deep water is defined as water depths greater than or equal to 5,000 ft (1,524 m). Leasing and royalty-relief data used are expressed in meters to be consistent with regulatory requirements. All other data are expressed in feet, corresponding to operational considerations. A few other definitions are useful at this point:

- *Proved Reserves* are those quantities of hydrocarbons that can be estimated with reasonable certainty to be commercially recoverable from known reservoirs. These reserves have been drilled and evaluated and are generally in a producing or soon-to-be producing field.
- *Unproved Reserves* can be estimated with some certainty (drilled and evaluated) to be potentially recoverable, but there is as yet no commitment to develop the field.
- *Known Resources* in this report refer to discovered resources (hydrocarbons whose location and quantity are known or estimated from specific geologic evidence) that have less geologic certainty and a lower probability of production than the Unproved Reserves category.
- *Industry-Announced Discoveries* refer to oil and gas accumulations that were announced by a company or otherwise listed in industry publications. These discoveries may or may not have been evaluated by MMS, and the reliability of estimates can vary widely.
- *Field* is defined as an area consisting of a single reservoir or multiple reservoirs grouped on, or related to, the same general geologic structural feature and/or stratigraphic trapping condition. There may be two or more reservoirs in a field that are separated vertically by intervening impervious strata or laterally by local geologic barriers or both.

More detailed definitions may be found in the annual *Estimated Oil and Gas Reserves, Gulf of Mexico Outer Continental Shelf, December 31, 2004* report (Crawford et al., 2008).

This report refers to developments both as fields (as defined above) and by operator-designated project names. It is important to note that the total number of fields, as defined by MMS criteria, and the total number of operator-designated projects may not be the same. A field name is assigned to a lease or a group of leases by MMS so that oil and natural gas resources, reserves, and production can be allocated on the basis of the unique geologic feature that contains the hydrocarbon accumulation(s). The field's identifying block number corresponds to the first lease qualified by MMS or the block where the primary structure is located. Therefore, more than one operator-designated project may be included in a single MMS-designated field.

Note that the term "oil" refers to both oil and condensate throughout this report and "gas" includes both associated and non-associated gas.

EXPANDING FRONTIER

When the original version of this report (Cranswick and Regg, 1997) was published in February 1997, a new era for the GOM had just begun with intense interest in the oil and gas potential of the deepwater areas. At that time there were favorable economics, recent deepwater discoveries, and significant leasing spurred on by the Deep Water Royalty Relief Act (DWRRA; 43 U.S.C. §1337). Historically, deepwater production began in 1979 with Shell's Cognac Field, but it took another 5 years before the next deepwater field (ExxonMobil's Lena Field) came online. Both developments relied on extending the limits of platform technology used to develop the GOM shallow-water areas.

Since then, deepwater exploration and production technology has tremendously advanced. In February 1997, there were 17 producing deepwater projects, up from only 6 at the end of 1992. Since then, industry has been rapidly advancing into deep water, and many of the anticipated fields have begun production. At the end of 2008, there were 141 producing projects in the deepwater GOM, up from 130 at the end of 2007 (Richardson et al., 2008).

Over the last 15 or so years, leasing, drilling, and production moved steadily into deeper waters. There are approximately 7,310 active leases in the U.S. GOM, 58 percent of which are in deep water. (Note that lease statuses may change daily, so the current number of active leases is an approximation.) Contrast this to approximately 5,600 active GOM leases in 1992, only 27 percent of which were in deep water. There was a maximum of 31 rigs drilling in deep water in 2008, compared with only 3 rigs in 1992. Likewise, deepwater oil production rose about 786 percent and deepwater gas production increased about 1,067 percent from 1992 to 2007. Production from seven deepwater fields began in 2008, including Thunder Horse, the largest daily producer in the GOM. **Appendix A** provides locations and additional information for these fields and projects.

ULTRA-DEEPWATER DRILLING AND DISCOVERIES (≥5,000 FT OR ≥1,524 M)

In 1986, the first discovery in the GOM in water depths greater than 5,000 ft (1,524 m) occurred with Mensa. Since that time, there have been 64 additional discoveries in the ultra-deep provinces of the Gulf (**Table 3**). The production from 13 of these discoveries is associated with the Independence Hub natural gas processing facility. Another 15 of the discoveries are associated with the Lower Tertiary trend.

In 2007, MMS reported a record number of 15 rigs drilling for oil and gas in water depths of 5,000 ft (1,524 m) or more in the GOM. Although this record has not yet been surpassed, MMS expects increased drilling activities in ultra-deep water, with 15 newbuild mobile offshore drilling units (MODU's) contracted for delivery to the GOM in 2009 through 2011. The MMS expects 2 new drillships and 6 new semisubmersible drilling rigs in 2009, 5 new drillships and 1 semisubmersible drilling rig in 2010, and 1 new semisubmersible drilling rig in 2011. There are also 4 semisubmersible rigs that are currently being upgraded to drill in ultra-deep water that are contracted for delivery to the GOM in 2009 and 2010. The newbuild *Stena DrillMAX I* drillship and the Seadrill *West Sirius* semisubmersible drilling rig were delivered to the GOM in 2008. All of the newbuild MODU's are being built with dynamic positioning systems and will not have to be moored to the seafloor. These newbuild MODU's will be capable of drilling in water depths from 7,500 to 12,000 ft (2,286 to 3,658 m) and will be capable of drilling wells from 30,000 to 40,000 ft (9,144 to 12,192 m) below the seafloor. There are several drilling contractors that have MODU's in construction for delivery in 2010 and 2011 that are not yet contracted with operators, and some of these MODU's are expected to operate in the GOM under future contracts.

Table 3. Discoveries in Water Depths Greater than 5,000 ft (1,524 m)

Project/Prospect	Area/Block	Water Depth (ft)[1]	Discovery Year
Constitution	GC 680	5,001	2001
GC767	GC 767	5,116	2004
Rigel	MC 252	5,227	1999
Ticonderoga	GC 768	5,259	2004
Big Foot	WR 29	5,268	2005
King	MC 84	5,303	1993
Mensa	MC 731	5,313	1986
Red Hawk	GB 877	5,329	2001
Goldfinger	MC 771	5,413	2004
Horn Mountain	MC 127	5,422	1999
Devil's Tower	MC 773	5,532	1999
Thunder Horse North	MC 776	5,662	2000
Thunder Bird	MC 819	5,672	2006
Thunder Hawk	MC 734	5,714	2004
Kaskida[3]	KC 292	5,721	2006
Kepler	MC 383	5,741	1987
La Femme	MC 427	5,782	2004
Seventeen Hands	MC 299	5,881	2001
Dalmatian	DC 48	5,876	2008
Thunder Horse	MC 778	6,082	1999
Freedom	MC 948	6,095	2008
Thunder Ridge	MC 737	6,108	2006
Ariel	MC 429	6,134	1995
Neptune (AT)	AT 575	6,203	1995
Tortuga	MC 561	6,302	2008
Isabela	MC 562	6,535	2007
King's Peak	DC 133	6,541	1993
Anstey	MC 607	6,601	1997
Atlantis	GC 743	6,612	1998
Bass Lite	AT 426	6,623	2001
Fourier	MC 522	6,895	1989
Blind Faith	MC 696	6,952	2001
Jack[3]	WR 759	6,962	2004

Table 3. Discoveries in Water Depths Greater than 5,000 ft (1,524 m) (*continued*)

Project/Prospect	Area/Block	Water Depth (ft)[1]	Discovery Year
St. Malo[3]	WR 678	6,991	2003
Aconcagua	MC 305	7,051	1999
Mission Deep	GC 955	7,068	2006
Julia[3]	WR 627	7,087	2007
Camden Hills	MC 348	7,206	1999
Shiloh	DC 269	7,509	2003
Coulomb	MC 657	7,558	1987
BAHA[3]	AC 600	7,620	1996
Hal[3]	WR 848	7,657	2008
Gotcha[3]	AC 856	7,714	2006
Callisto	MC 876	7,790	2001
San Jacinto[2]	DC 618	7,805	2004
Q[2]	MC 961	7,926	2005
Merganser[2]	AT 37	7,939	2001
Spiderman[2]	DC 621	8,082	2003
Great White[3]	AC 857	8,119	2002
Cascade[3]	WR 206	8,152	2002
Vortex[2]	AT 261	8,344	2002
Mondo NW Extension[2]	LL 1	8,351	2005
Mondo Northwest[2]	LL 2	8,362	2004
Jubilee Extension[2]	LL 309	8,774	2005
Jubilee[2]	AT 349	8,778	2003
Atlas NW[2]	LL 5	8,807	2004
Chinook[3]	WR 469	8,831	2003
Atlas[2]	LL 50	8,944	2003
Cheyenne[2]	LL 399	8,983	2004
Tiger[3]	AC 818	9,004	2004
Silvertip[3]	AC 815	9,226	2004
Stones[3]	WR 508	9,571	2005
Tobago[3]	AC 859	9,627	2004
Trident[3]	AC 903	9,721	2001
Diamond	LL 370	9,975	2008

[1] Water depths are approximate and may be the location of a completed well, or an average of completed wells, or the location of the discovery well in the block.

[2] Projects associated with the Independence Hub natural gas processing facility.

[3] Projects associated with the Lower Tertiary trend.

CHALLENGES AND REWARDS

Significant challenges exist in deep water in addition to environmental considerations. Deepwater operations are very expensive and often require significant amounts of time between initial exploration and first production. Despite these challenges, operators often reap great rewards. **Figure 3** shows the history of discoveries in the deepwater GOM. There was a shift toward deeper water over time, and the number of deepwater discoveries continues at a steady pace.

In addition to the significant number of deepwater discoveries, the flow rates of deepwater wells and the field sizes of deepwater discoveries are often quite large. These factors are critical to the economic success of deepwater development. **Figure 4** illustrates the estimated sizes and locations of 127 proved deepwater fields. In addition to their large sizes, the fields have a wide geographic distribution and range in geologic age from Pleistocene through Paleocene.

Figure 5 illustrates existing and potential hubs for deepwater production. For purposes of this report, deepwater hubs are defined as surface structures that host production from one or more subsea projects. These hubs represent the first location where subsea production comes to the surface, and the hubs are the connection point to the existing pipeline infrastructure. Note that potential hubs are moving into deeper waters, expanding the infrastructure and facilitating additional development in the ultra-deepwater frontier.

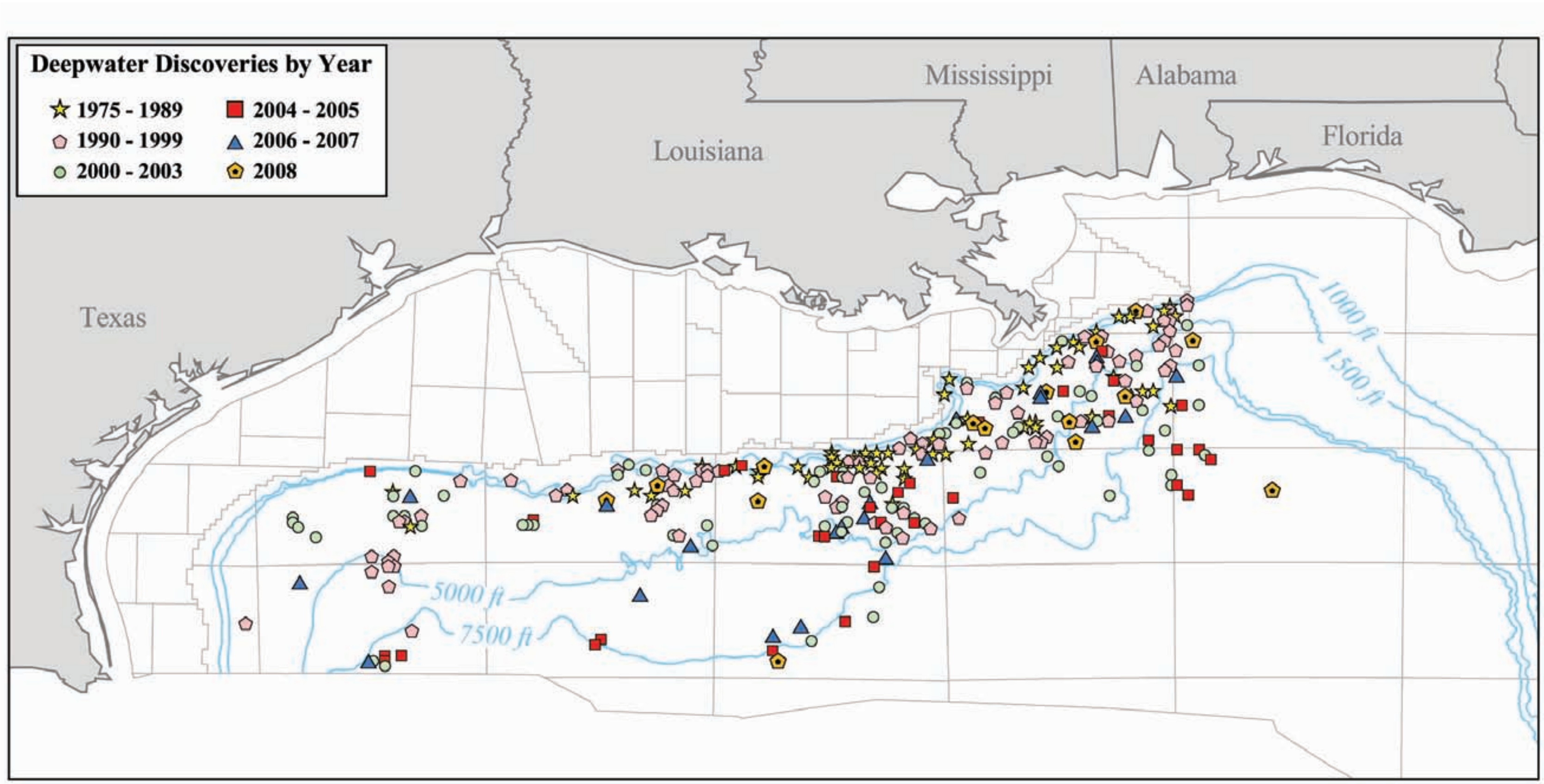


Figure 3. Deepwater discoveries by year.

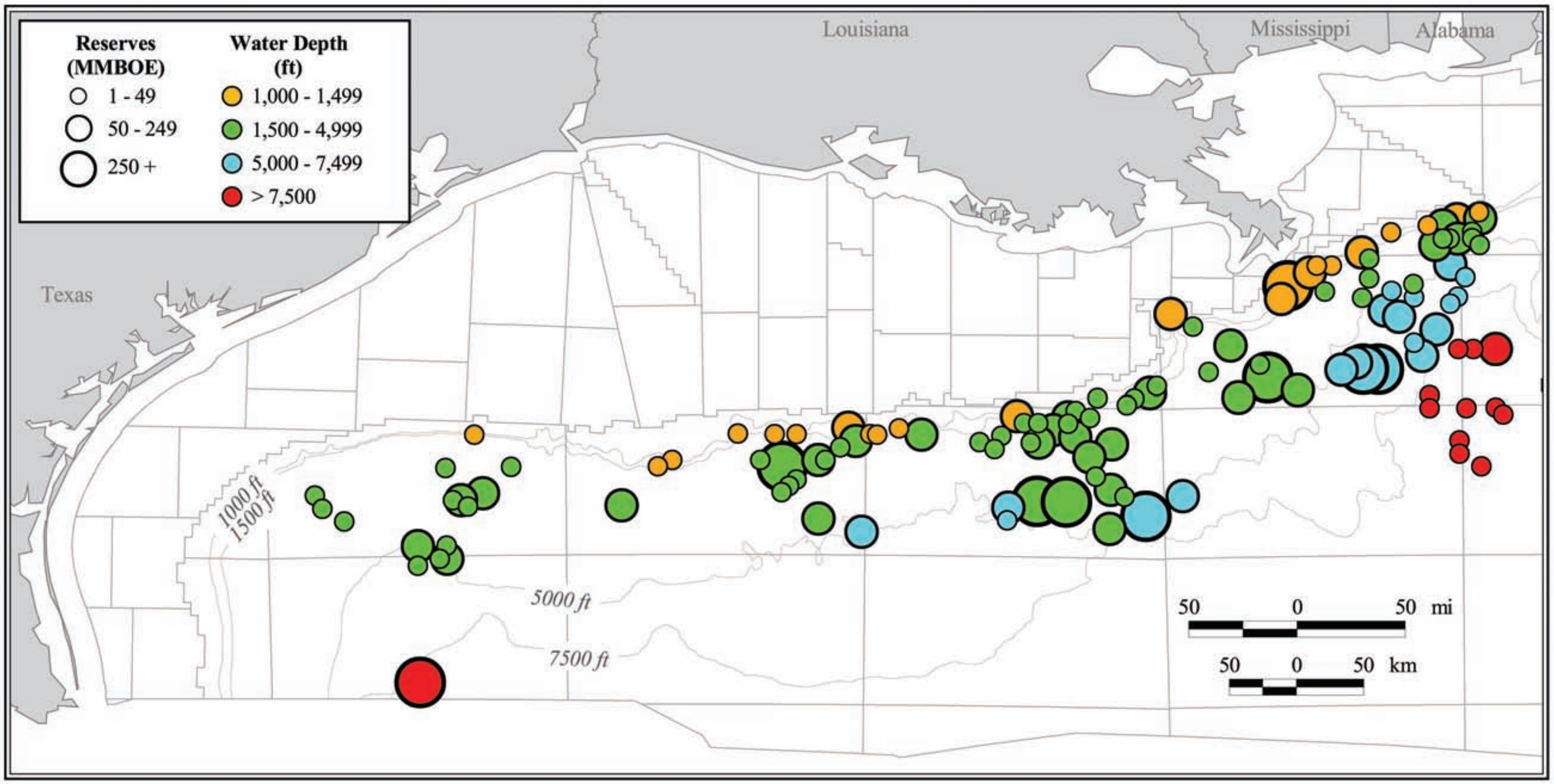


Figure 4. Estimated volume of proved deepwater fields.

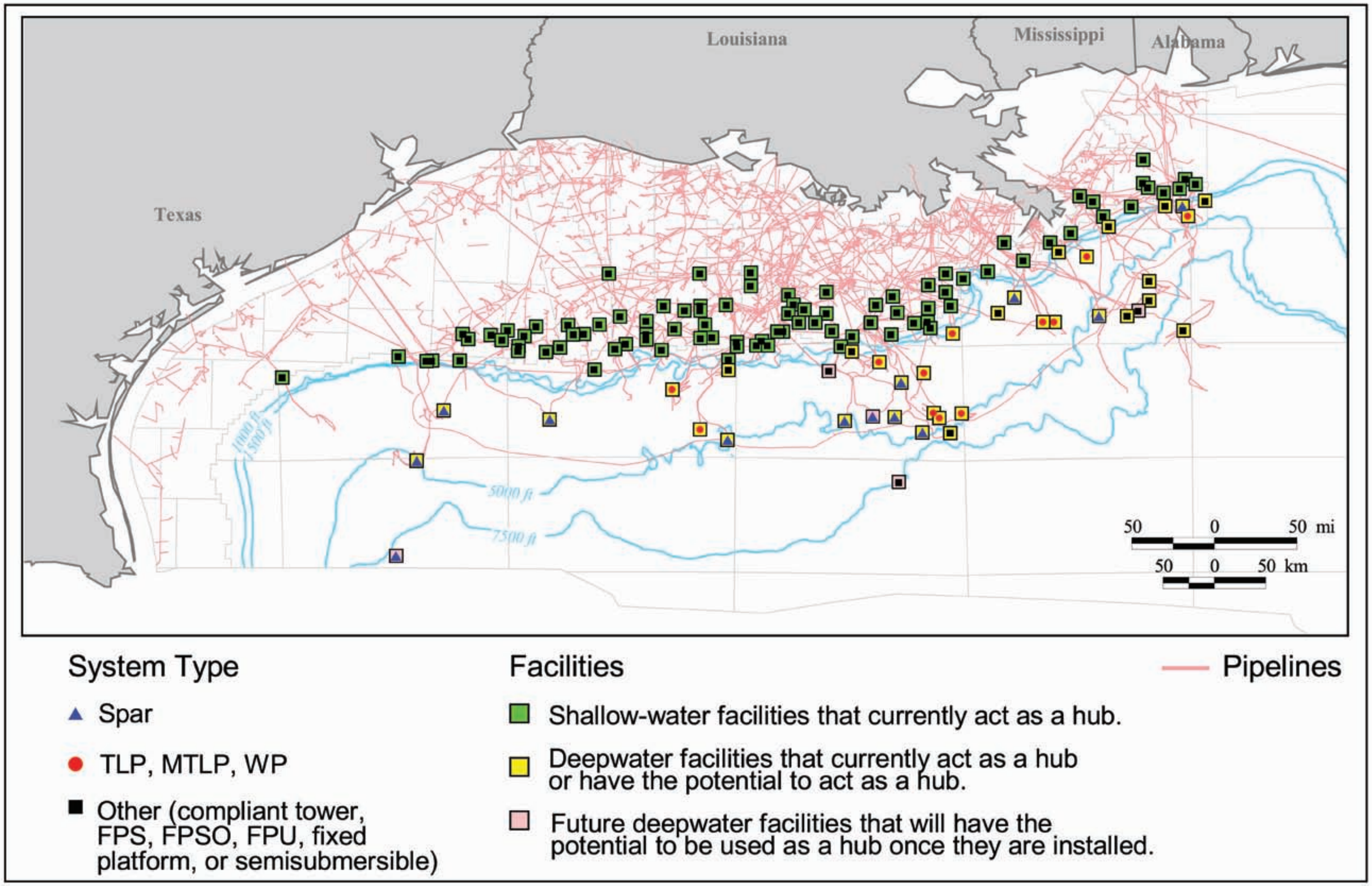


Figure 5. Current, potential, and future hub facilities.

LEASING AND ENVIRONMENT

5-YEAR OCS OIL AND GAS LEASING PROGRAM

Section 18 of the OCS Lands Act (OCSLA) requires the Secretary of the Interior to prepare and maintain a 5-Year Program. The program reflects a proper balance among the potential for the discovery of oil and natural gas, the potential for environmental damage, and the potential for adverse effects on the coastal zone. The 5-Year Program also must provide for the receipt of fair market value by the Federal Government for land leased and rights conveyed.

When approved, the leasing program consists of scheduled lease sales for a 5-year period, along with policies pertaining to the size and location of sales and the receipt of fair market value. The purpose of a schedule is to increase the predictability of sales in order to facilitate planning by industry, affected states, and the general public. The schedule indicates the timing and location of sales and shows the presale steps in the process that lead to a competitive sealed bid auction for a specific OCS area. To facilitate the scheduling of and preparation for sales in the 5-Year Program, the OCS is divided into administrative geographical units called planning areas.

In preparing a new 5-Year Program, the Secretary solicits comments from coastal State Governors and localities, tribal governments, the public, the oil and natural gas industry, environmental groups, affected Federal agencies, and Congress. The MMS requests comments at the start of the process of developing a new program and following the issuance of each of the first two versions: (1) the draft proposed program with a 60-day comment period; and (2) the proposed program with a 90-day comment period. The third and last version, the proposed final program, is prepared with a 60-day notification period following submission to the President and Congress. After 60 days, if Congress does not object, the Secretary may approve the program.

In addition to the steps required by Section 18 of the OCSLA, the Secretary must comply with the requirements of the National Environmental Policy Act (NEPA). Additional scoping may occur and an environmental impact statement (EIS) on the 5-Year Program is prepared. During the comment period on the draft EIS, public hearings are held in various coastal locations around the Nation. After the receipt of comments, a final EIS is prepared. A record of decision that formalizes the alternatives that were selected from the final EIS is prepared.

Each lease sale proposed in the program's schedule must also undergo a NEPA evaluation and presale coordination steps required by Section 19 of the OCSLA. An environmental assessment that is specific to the individual lease sale is usually prepared. These documents examine new information and changes that have occurred since the final EIS was prepared. Consultation is conducted with the states during the process, and consistency with each affected state's Coastal Zone Management (CZM) program is determined before the lease offering transpires.

The listing below shows the major sequential steps in the process after adoption of a 5-Year Program.

- Call for Information and Nominations and Notice of Intent to Prepare an EIS
- Area identification
- Draft EIS

- Public hearings
- Final EIS and CZM consistency determination
- Record of decision
- Sale-specific NEPA evaluation
- Proposed Notice of Sale
- Governor's comments
- Final Notice of Sale
- Sale
- Decision to accept or reject bids
- Issuance of leases

The entire 5-Year Program process takes approximately 2 years to complete. The lease sale schedule is reviewed annually after its approval. A more in-depth discussion of the leasing process is provided in MMS's document, *Leasing Oil and Gas Resources: Outer Continental Shelf*. The document is available through MMS's Web site at http://www.mms.gov/ld/PDFs/GreenBook-LeasingDocument.pdf.

The MMS is currently operating under its proposed OCS Oil and Gas Leasing Program for 2007-2012. This 5-Year Program proposes 12 oil and gas lease sales in the GOM—5 sales in the Western Planning Area, 6 sales in the Central Planning Area, and 1 sale in the Eastern Planning Area. Detailed schedule information is available from MMS's Web site at http://www.mms.gov/offshore/2007-2012LeaseSaleSchedule.htm. More information on the 5-Year Program may be gleaned from MMS's Web site at http://www.mms.gov/5-year/WhatIs5YearProgram.htm.

WATER-DEPTH INTERVALS

The Gulf of Mexico OCS is divided into three sectors—the Western, Central, and Eastern Planning Areas (**Figure 6**). Additionally, many of the data presented in this report are subdivided according to water depth. These divisions (1,000, 1,500, 5,000, and 7,500 ft) are also illustrated in **Figure 6**, along with the deepwater royalty-relief zones (400, 800, 1,600, and 2,000 m) mandated by the Energy Policy Act of 2005. Not all leases within a colored area are eligible for royalty relief because of the differing vintage of leases included within the area.

LEASING ACTIVITY

Figure 7 depicts all active leases in the GOM at the end of calendar year 2008. The pie chart inset in this figure highlights the relative percentage of active leases in each operational water-depth category used in this report. Note that approximately 57 percent of the leased blocks are located in water depths greater than 1,000 ft (305 m), up from 54 percent in 2007. The limited number of active leases in the Eastern Planning Area is related to leasing restrictions. The approximate number of active leases for certain water-depth ranges is shown in **Table 4**.

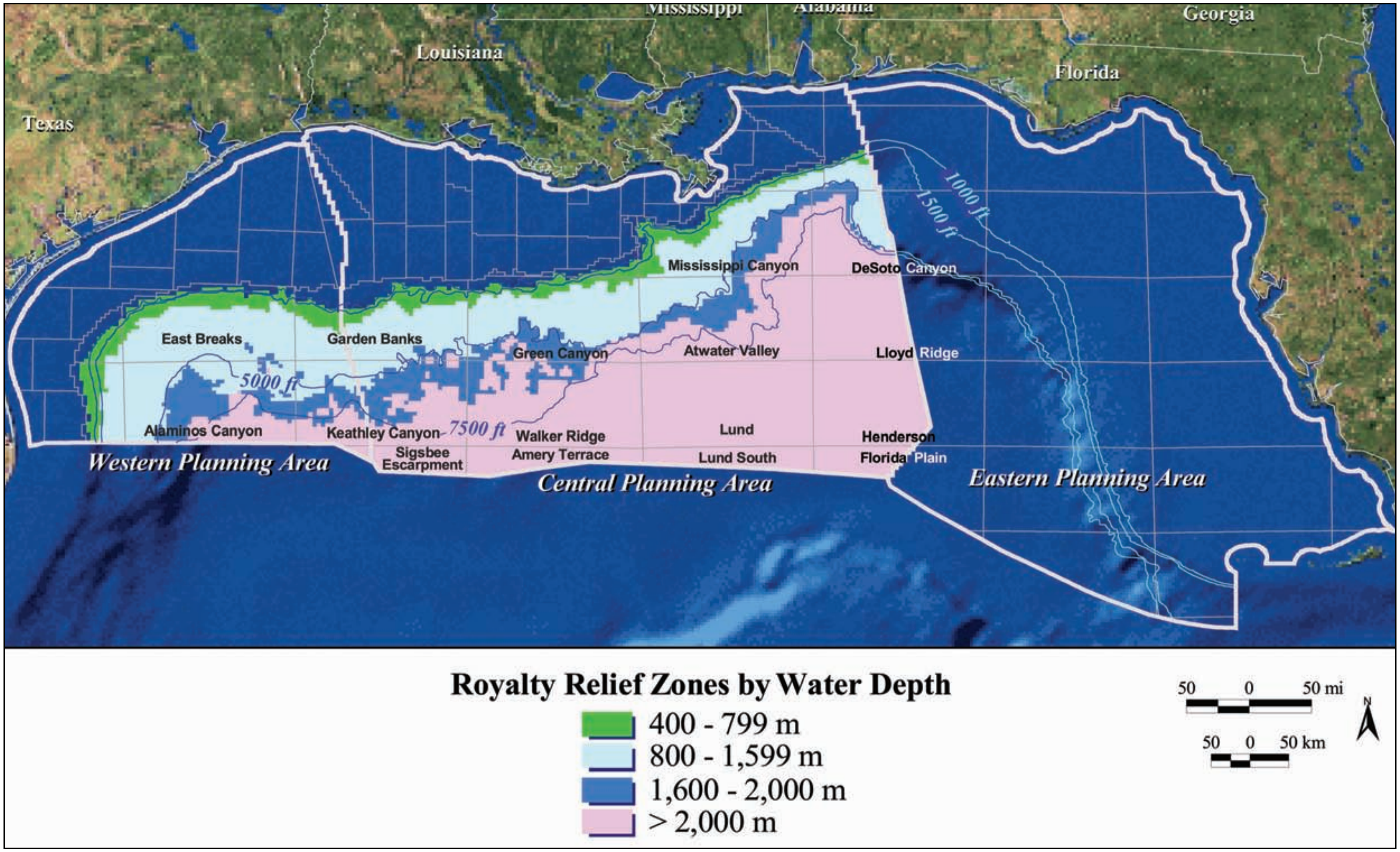


Figure 6. Deepwater royalty-relief zones with planning areas and selected bathymetry.

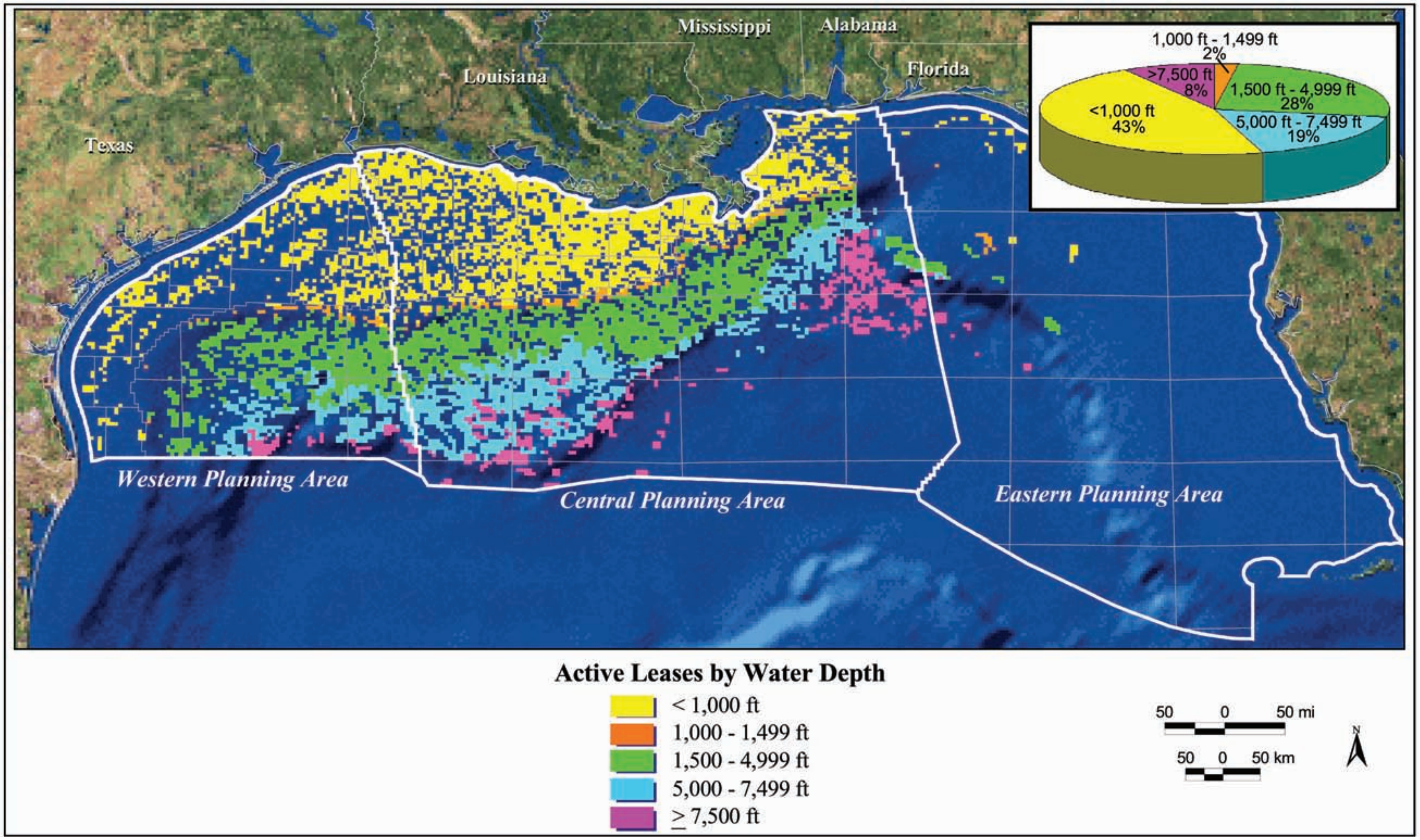


Figure 7. Active leases by water depth.

Table 4. Number of Active Leases by Water-Depth Interval

Number of Active Leases	Water Depth ft	Water Depth m
3,096	<1,000	<305
152	1,000-1,499	305-457
2,066	1,500-4,999	458-1,524
1,398	5,000-7,499	1,525-2,286
598	>7,500	>2,286

Central Lease Sale 206

Central Sale 206 was held on March 19, 2008. This sale attracted $3,677,688,245 in high bids—the most since Federal offshore leasing began in 1954. The MMS received 1,057 bids from 85 companies on 615 blocks. The sum of all bids for this sale was $5,740,047,263. Sale 206 ultimately resulted in the award of 603 leases. The MMS rejected high bids totaling $6,477,661 on 11 blocks as insufficient for fair market value, and one block was forfeited when the company withdrew their bid. The accepted high bids for the sale totaled $3,671,052,702.40.

About 67 percent of the blocks receiving bids were located in deep water [400 m (1,312 ft) or deeper] with approximately 34 percent of the blocks bid upon in ultra-deep water—more than 1,600 m (5,249 ft). The MMS considers water depths greater than 400 m (1,312 ft) and 1,600 m (5,249 ft) as deep water and ultra-deep water, respectively, for sale purposes.[1] The deepest block to receive a bid was Lloyd Ridge Block 286 in 3,076 m (10,092 ft) of water. The highest bid accepted on a block was $105,600,789 made by Anadarko E&P Company, Murphy Exploration & Production Company USA, and Samson Offshore Company for Green Canyon Block 432. Funds from the total high bids will be distributed to the general fund of the U.S. Treasury, shared with the affected States, and set aside for special uses that benefit all 50 States.

Eastern Lease Sale 224

Held on the same day as Sale 206, Eastern Sale 224 attracted $64,713,213 in high bids. This sale offered 118 whole or partial unleased blocks covering 546,971 acres from what is known as the 181 Area (**Figure 2**). The MMS received 58 bids from six companies on 36 blocks. The sum of all bids for this sale was $72,137,645. Sale 224 ultimately resulted in the award of leases for all blocks bid upon. All of the blocks offered in this sale are located in water depths greater than 800 m (2,625 ft). The States of Alabama, Louisiana, Mississippi, and Texas will share in 37.5 percent of the high bids on these blocks, as well as all future revenues generated from this acreage.

[1] The definitions of deep water and ultra-deep water used for lease sales statistics are based on the DWRRA established royalty suspension intervals.

Western Lease Sale 207

Held on August 20, 2008, Western Sale 207 attracted $487,297,676 in high bids. The MMS received 423 bids from 53 companies on 319 blocks comprising over 1.8 million acres offshore Texas. The sum of all bids received totaled $607,134,968. Sale 207 ultimately resulted in the award of 313 leases. The MMS rejected high bids totaling $3,338,272 on six blocks as insufficient for fair market value. The accepted high bids for the sale totaled $483,959,404.

Approximately 78 percent of the blocks receiving bids were in deep water [400 m (1,312 ft) or deeper], and approximately 21 percent of the blocks receiving bids were in ultra-deep water—more than 1,600 m (5,249 ft). The deepest block bid on was Alaminos Canyon Block 783 in 2,977 m (9,767 ft) of water. The highest bid accepted on a block was $61,110,000 submitted by Statoil Gulf of Mexico LLC for Alaminos Canyon Block 380. Funds from the total high bids will be distributed to the general fund of the U.S. Treasury, shared with the affected States, and set aside for special uses that benefit all 50 States.

Central Lease Sale 208

Held on March 18, 2009, Central Sale 208 attracted $703,048,523 in high bids. The MMS received 476 bids from 70 companies on 348 blocks comprising over 1.9 million acres offshore Alabama, Louisiana, and Mississippi. The sum of all bids received totaled $933,649,315.

Approximately 70 percent of the blocks receiving bids were in deep water [400 m (1,312 ft) or deeper], and approximately 42 percent of the blocks receiving bids were in ultra-deep water—more than 1,600 m (5,249 ft). The highest bid received on a block was $65,611,235 submitted by Shell Gulf of Mexico Inc. for Mississippi Canyon Block 721.

Areas for lease in Sale 208 included approximately 4.2 million acres from what is known as the 181 South Area in the southeastern portion of the sale area (**Figure 2**). The 181 South Area has been off-limits to exploration for over 20 years. A total of 13 blocks received bids in this area, and the high bids for these blocks totaled $6,476,545. The States of Alabama, Louisiana, Mississippi, and Texas will share in 37.5 percent of the high bids on these blocks, as well as all future revenues generated from this acreage.

LEASING TRENDS

Prior to the mid-1990's, leasing activities in the GOM were concentrated in the shallow-water blocks located on the continental shelf [water depths of approximately 200 m (656 ft)] or less. With the passage of the DWRRA in 1995, royalty-relief incentives were established for new leases on the basis of specific water-depth intervals. The water-depth categories depicted in **Figure 8** reflect the divisions used in the DWRRA. This figure shows the magnitude of the DWRRA's impact on leasing activities. Significant deepwater leasing activities began in 1995 and showed remarkable increases from 1996 through 1998, especially in water depths greater than 800 m (2,625 ft), where the greatest royalty relief was available. During this time, leasing activities on shallow-water blocks diminished. After the large lease sales of 1997 and 1998, the number of leases issued in water depths greater than 800 m (2,625 ft) dropped by nearly half and remained relatively steady until increasing in 2007 and 2008. This increase is due in part to the expiration of the primary terms of leases issued in 1997 and 1998, which led to the record setting lease sales in 2007 and 2008.

Figure 9 was derived from the data in **Figure 8**, but it displays the deepwater depth categories used elsewhere in this report. (Shallow-water data are excluded from **Figure 9**.) These data show the rapid increase in leasing activity that began in 1995 and continued through 1998. Although leasing activity plummeted in 1999, higher levels of leasing activity returned after 2000. Several factors initiated this resurgence, including high oil and gas prices and several major discoveries, such as Tahiti, Great White, and Thunder Horse.

FUTURE LEASE ACTIVITY

The number of leases that will be relinquished, terminated, or expired will influence activity in future lease sales. Given the fact that most companies can drill only a small percentage of their active leases, it is likely that many high-quality leases will expire without being tested. Ultimately, an untested and undeveloped lease will expire and possibly be leased again.

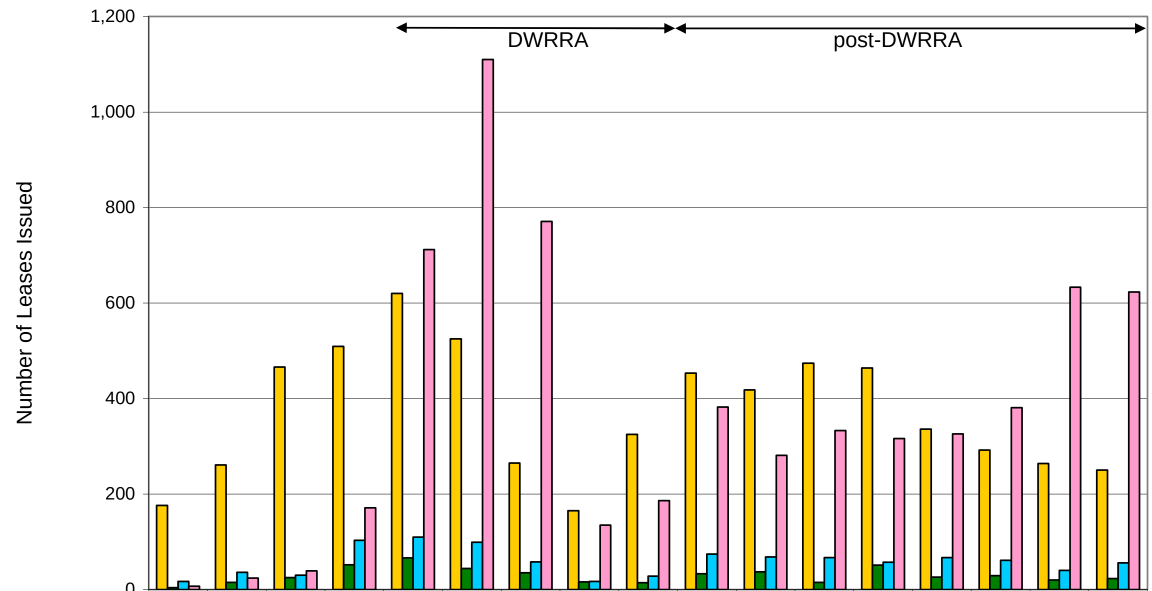
Figure 10 shows leases that may expire from 2009 to 2020 in 2-year intervals. The data used in creating these figures assume that each lease expires at the end of its primary lease term (without a lease-term extension). Note that lease terms vary according to water depth. Primary lease terms for water-depth intervals are as follows: 5 years for blocks in less than 400 m (1,312 ft); 8 years for blocks in 400-799 m (1,312-2,621 ft) (pursuant to 30 CFR 256.37, commencement of an exploratory well is required within the first 5 years of the initial 8-year term to avoid lease cancellation); and 10 years for blocks in 800 m (2,625 ft) or greater.

GRID PROGRAMMATIC ENVIRONMENTAL ASSESSMENTS

A biologically based grid system was developed by MMS as part of its comprehensive strategy to address deepwater issues. The grid system initially divided the Gulf into 17 areas or "grids" of biological similarity. Since then, 4 grids were added to the system to address the modified Sale 181 area and the new eastern boundary of the Central Planning Area in effect since 2007 for Sale 205, making a total of 21 grids for the Gulf (**Figure 11**). Under this system and under most circumstances, MMS will prepare a Programmatic Environmental Assessment (PEA) that characterizes and analyzes a proposed development project within context of the entire grid. Grid PEA's are comprehensive in terms of the impact-producing factors and the environmental and socioeconomic resources described and analyzed in it. Grid PEA's also address potential cumulative effects of projects proposed within the grid. Other information on publicly announced projects within the grid is discussed, as well as any potential effects expected from future developmental activities. Projects selected for the PEA's are representative of the types of development expected within the grid. For example, a good candidate for a Grid PEA would be a proposed development of a new surface structure that might serve as a "hub" for future development within the grid.

Once a Grid PEA has been completed, it will serve as a reference document for "tiering" and "incorporation by reference" encouraged by the implementing regulations of NEPA. Future environmental evaluations may reference appropriate sections from the PEA to reduce duplication and to focus on issues and effects related to specific proposals.

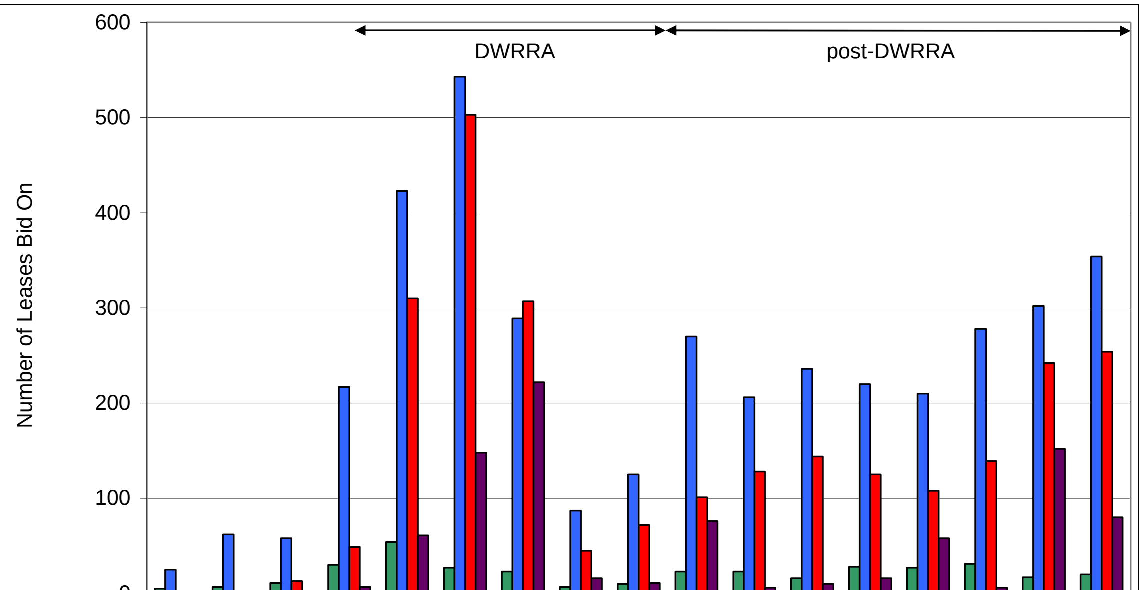
Table 5 shows the status of the Grid PEA's.



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
< 200 m	176	261	466	509	620	525	265	165	325	453	418	474	464	336	292	264	250
200 - 400 m	4	15	25	52	66	44	35	16	14	33	37	15	51	26	29	20	23
400 - 800 m	17	36	30	103	110	99	58	17	28	74	68	67	57	67	61	40	56
> 800 m	7	24	39	171	712	1,110	771	135	186	382	281	333	316	326	381	633	623

Lease Sale Year

Figure 8. Number of leases issued each year subdivided by DWRRA water-depth categories.



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1,000 - 1,499 ft	5	7	11	30	54	27	23	7	10	23	23	16	28	27	31	17	20
1,500 - 4,999 ft	25	62	58	217	423	543	289	87	125	270	206	236	220	210	278	302	354
5,000 - 7,499 ft	1	0	13	49	310	503	307	45	72	101	128	144	125	108	139	242	254
> 7,500 ft	0	0	0	7	61	148	222	16	11	76	6	10	16	58	6	152	80

Lease Sale Year

Figure 9. Number of leases bid on for each deepwater interval.

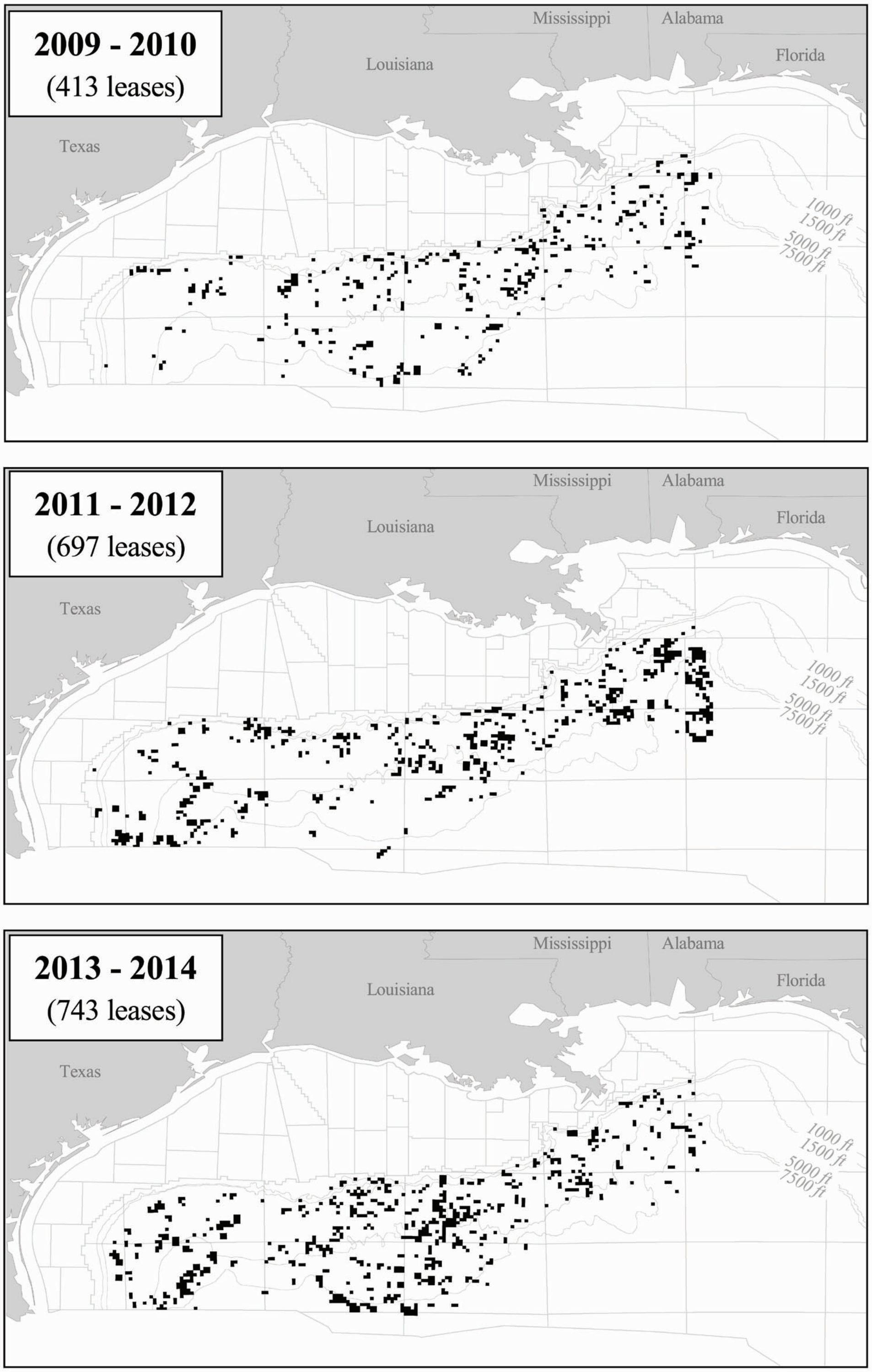


Figure 10. Anticipated lease expirations from 2009 to 2019.

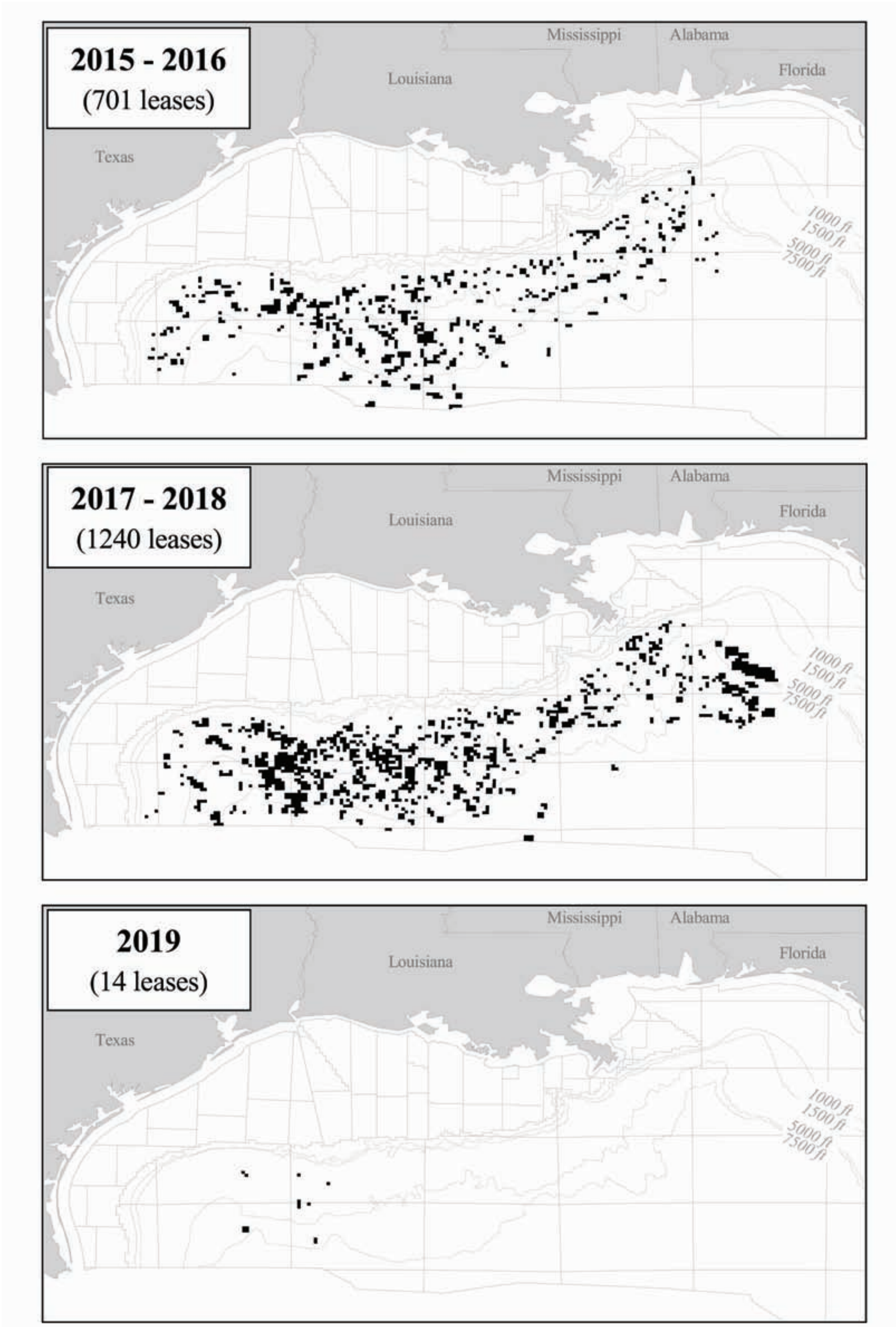


Figure 10. Anticipated lease expirations from 2009 to 2019 (*continued*).

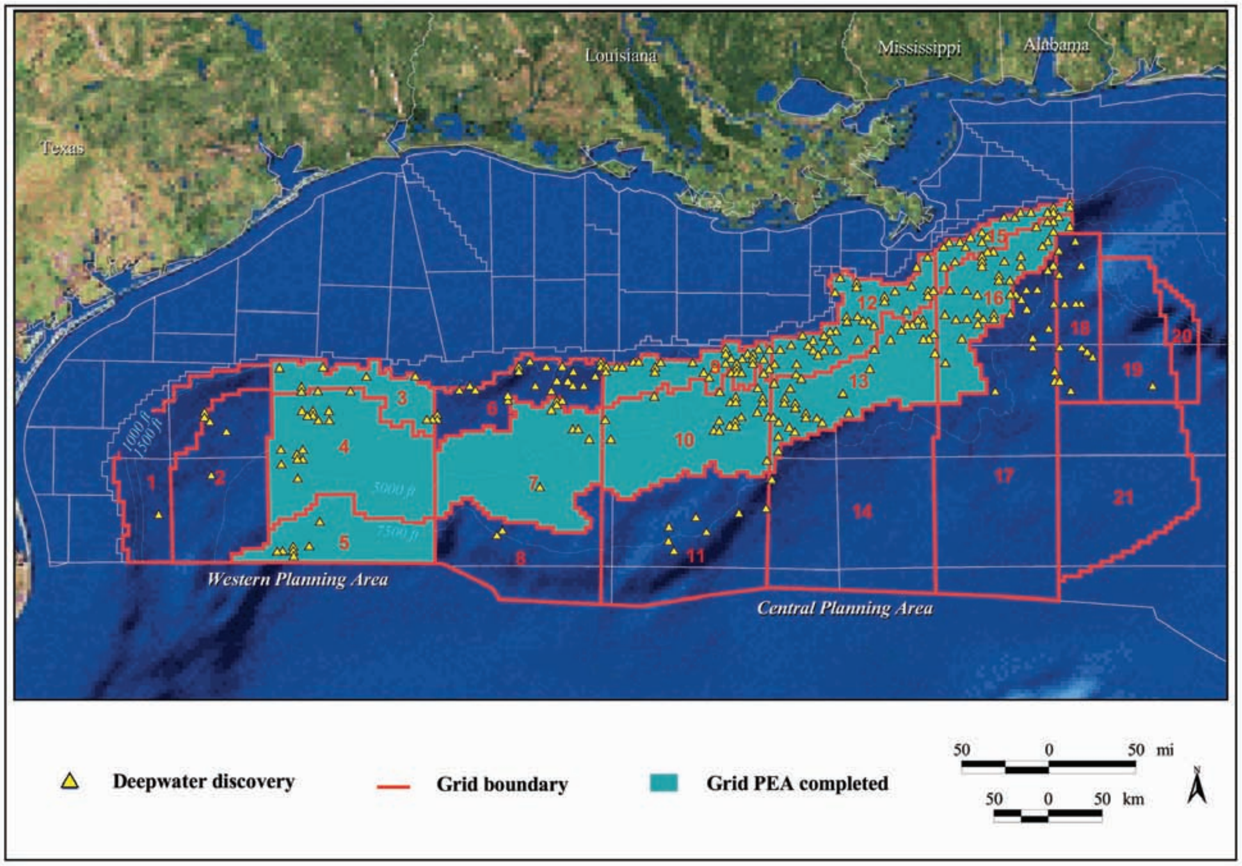


Figure 11. Grid PEA status.

Table 5. Grid PEA Status within the Central and Western Planning Areas

Grid	Project	Company	Plan	Area & Blocks
3	Gunnison	Kerr-McGee	N-7625	GB 667, 668 & 669
4	Nansen	Kerr-McGee	N-7045	EB 602 & 646
5	Perdido	Shell	N-8809	AC 812, 813, 814 & 857
7	Magnolia	Conoco	N-7506	GB 783 & 784
9	Phoenix	Energy Resource Technology	S-7156	GC 236 & 237
10	Holstein	British Petroleum	N-7216	GC 644 & 645
12	Medusa	Murphy	N-7269	MC 538 & 582
13	Marco Polo	Anadarko	N-7753	GC 608
15	Matterhorn	TotalFinaElf	N-7249	MC 243
16	Thunder Horse	British Petroleum	N-7469	MC 775-778 & 819-822

RECENT ENVIRONMENTAL STUDIES BY MMS

Deepwater Currents

Since 1999 industry has reported significant currents below the 3,000-ft (914-m) water-depth level. This information led to a Safety Alert (USDOI, MMS, 2000) and subsequent studies of deep currents by MMS (Hamilton et al., 2000 and 2003). The Hamilton et al. investigations spawned additional deepwater current studies funded by MMS and were discussed in the Deepwater Gulf of Mexico 2008 Report (Richardson et al., 2008). In 2008, three new studies were made available to the public; these studies focus on currents near the Sigsbee Escarpment, in the Eastern GOM and in the northwestern GOM. In October 2008, MMS awarded a significant new contract to study currents in the deepwater GOM.

Concentrating on currents near the Sigsbee Escarpment (McKone et al., 2007), Louisiana State University deployed four full-water column moorings in the GOM in February 2000 and removed the last mooring in June 2004. These moorings were designed to measure current, along with temperature, salinity, and pressure at various depths throughout the water column. The first two moorings, Deployments 1 and 2, were located on top of the Sigsbee Escarpment in approximately 2,200 m (7,218 ft) of water. These two mooring were combined to form a single time series. The last two moorings, Deployments 3 and 4, were positioned at the base of the Sigsbee Escarpment in approximately 3,000 m (9,843 ft) of water. Strongest surface currents occurred when the Loop Current or Loop Current eddies (both anticyclonic and cyclonic) flowed near or over the mooring. Of the 24 events investigated in detail, four of the events showed surface to bottom coherence in flow, which corresponded with the intensification of a Loop Current frontal eddy cyclone in close proximity to the mooring. Relatively strong bottom currents to the northeast occurred when a large warm-core anticyclonic Loop Current eddy (ring) passed south of the mooring.

In May 2008, MMS announced the availability of a new study report, *Deepwater Currents in the Eastern Gulf of Mexico: Observations at 25.5°N and 87°W* (Inoue et al., 2008). This report presents the analysis of current data collected at 87°W., 25.5°N. in water depths of approximately 3,600 m (11,811 ft), within a narrow channel connecting the eastern and central basins of the GOM. The mooring is an entire water-column array over a nearly flat bottom. The data suggest that the GOM can be viewed as a two-layer system with the interface at 700-800 m (2,297-2,625 ft) driven by the Loop Current and coinciding with the sill of the Florida Straits. The lower layer tends to have uniform currents in the vertical and speeds of 10-30 centimeters per second (0.3-1 feet per second). Short events of near uniform currents from top to bottom were observed and coincided with a Loop Current extended to its maximum northward position shortly before shedding an eddy.

Focusing on the northwestern GOM, in a new study report, *Study of Deepwater Currents in the Northwestern Gulf of Mexico, Volume I: Executive Summary* (Donohue et al., 2008a) and *Volume II: Technical Report* (Donohue et al., 2008b), 13 moored arrays, in water depths ranging from 500 to 3,200 m (1,640 to 10,499 ft) were used to document upper- and lower-layer current, temperature, and salinity fields in the area west of 93° W. longitude, north of the Exclusive Economic Zone, and south and east of the 200-m isobath. Moored data collection began in March 2004 and ended in June 2005. For the entire field measurement interval, satellite remote-sensing observations (altimetry, sea-surface temperature, and ocean color) were used to provide a context for the upper-layer field measurements and to characterize the associated circulation processes and patterns. The objectives of this study were (1) to collect current data to increase our deepwater database and knowledge of the deep circulation in the northwestern GOM; (2) to gather information to estimate oceanographic parameters needed to make experimental designs of full-scale, physical oceanography studies in deep water; and (3) to provide information to use in oil-spill analyses, including the emerging deep spill analysis and other ongoing studies, to help evaluate exploration plans and to contribute to the preparation of NEPA documents.

The MMS awarded a $5.5 million contract to Science Applications International Corporation (SAIC) to conduct a 5-year study of the GOM Loop Current in the Eastern GOM (USDOI, MMS, 2008a). Nine moorings, or anchored lines, will be placed in Gulf waters for approximately 30 months. The instruments attached to the moorings will measure current strength, water temperature, and salinity levels. Scientists from the Atlantic Oceanographic and Meteorological Lab will join SAIC to study the thermal structure of the Loop Current and hope to use this data to more accurately forecast the intensification of hurricanes entering the GOM. In addition, scientists from Princeton University, the University of Rhode Island and the University of Colorado are part of the SAIC team to carry out the state-of-the-art modeling, deep ocean circulation field observations, and the remote-sensing observations for this study.

Sperm Whale Seismic Study

The MMS released the results of a 6-year, $9.3 million study on sperm whales, an endangered species living in the northern GOM. The report, *Sperm Whale Seismic Study in the Gulf of Mexico: Synthesis Report* (Jochens et al., 2008), presents results from the Sperm Whale Seismic Study (SWSS) and gives recommendations for future study. The SWSS focused on the effects of seismic activities on sperm whales living in an area that is highly industrialized with oil and gas exploration and production activities. One finding supported by SWSS data is that northern GOM sperm whales are a distinct stock; that is, they show genetic differences from other sperm whales world-wide. Also, based on tag location data, the Gulf sperm whales showed no discernible seasonal migration. The study also did not find any horizontal avoidance of seismic sounds, meaning the whales did not alter their visible behavior on the surface when exposed to seismic sounds. Fifteen Federal and State agencies, universities, and organizations collaborated to meet the study's objectives: (1) establish baseline information about the whales' biology and behavior; (2) characterize the whales' habitat and how the whales use their habitat; and (3) determine possible changes in the whales' behavior when they experience human-made noise. Data gathered during SWSS provide insights into daily and seasonal movements, abundance, group structure, diving and other behaviors, habitat characteristics, and response to human-made noise of sperm whales in the northern GOM. This information will help MMS evaluate whether whales prefer some locations, what effects human activities (such as seismic surveys) may have on the whales and possible mitigation measures.

Chemosynthetic Communities

The study report, *Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico: Interim Report* (Brooks et al., 2008), represents the first report for a large multidisciplinary study to investigate chemosynthetic communities and deepwater, hard-bottom communities, including deepwater corals, below a depth of 1,000 m (3,281 ft) in the northern GOM. This project is a collaboration between MMS and the National Oceanic and Atmospheric Administration's (NOAA) Office of Ocean

Exploration and Research sponsored by the National Oceanographic Partnership Program. The report compiles detailed information regarding operational procedures, stations occupied, sampling activity, and preliminary results. The information in this report is a compilation of two cruises. A 2-week reconnaissance cruise was conducted from the vessel R/V *Gyre* from March 11-25, 2006, including drift camera work and trawling and box core sampling. A subsequent cruise was conducted on the Wood's Hole Oceanographic Institute research vessel R/V *Atlantis* and the submersible *Alvin* from May 7 through June 2, 2006. Results reported were obtained by analysis of the sampling information and data during these cruises and immediately afterward. New chemosynthetic communities and deepwater coral communities were discovered at numerous sites. In February 2007, several study sites were mapped in great detail using the C&C Technologies Autonomous Underwater Vehicle in preparation for intensive sampling during the 2007 field season. A final report is expected in late 2009.

Deepwater Coral

The new study report, *Lophelia Reef Megafaunal Community Structure, Biotopes, Genetics, Microbial Ecology, and Geology (2004-2006)* (Sulak et al., 2008), represents results from a multidisciplinary project conducted by the USGS supporting the needs of MMS and was complimentary and concurrent with a separate MMS study that resulted in MMS publication OCS Study 2007-044 by Continental Shelf Associates (CSA) (with the same title). Subject areas in the USGS report include demersal fish associated with *Lophelia* coral biotopes, deep-sea coral biodiversity and molecular assessment, expressed genes in *Lophelia*, microbial ecology of *Lophelia*, deepwater antipatharian sclerochronology, and hard structure geological analysis of *Lophelia* substrate. Field sampling cruises were performed at a total of up to five locations in the northern GOM utilizing Harbor Branch Foundation vessels and one of the *Johnson Sea Link* submersibles in 2004 and 2005. The R/V *Tommy Munro* was used for an additional sampling cruise in 2005. Both samples and scientists were exchanged between the collaborating projects by CSA/MMS and USGS. Results include the first quantitative analysis of fishes associated with *Lophelia* reefs in the GOM, patterns of *Lophelia* genetic differentiation across 290 km (180 mi) of the northern GOM, discovery of new expressed genes in *Lophelia,* significant differences of bacterial molecular analysis between *Lophelia* sites and unexpected variations in substrate mineralogy between *Lophelia* sites. Results of this study will be utilized to develop additional studies of hard-bottom habitats in the deep GOM and will also enhance the ability of MMS to protect sensitive deepwater biological features.

On November 24, 2008, MMS announced a $3.7 million, 4-year study of deepwater corals in the GOM (USDOI, MMS, 2008b). The study contract focuses on deepwater coral communities that have formed both naturally and on oil and gas platforms and shipwrecks. The first round of the project, primarily dedicated to the exploration of shipwreck sites, took the researchers to a remarkable discovery of a copper-clad sailing schooner likely dating to the early 1800's. Another wreck site visited, confirmed to be the *Gulfoil*, a tanker sunk by a German U-boat in 1942, was covered with dense thickets of the deepwater coral *Lophelia.* The study marks the first time coral community areas below 1,000 ft (305 m) will be investigated using remotely-operated vehicles. Study results will be used by MMS to create or modify existing regulatory policies and will help MMS protect these important habitats from the potential impacts of oil and gas exploration. The study includes 3 years of field work using research vessels and underwater vehicles provided by NOAA's Office of Ocean

Exploration and Research. During the second round of field work, dedicated to exploration and sampling of both known deepwater coral habitats and new unknown hard-bottom sites, scientists are collecting numerous samples of vibrant corals for analysis. Deepwater corals in the GOM have only recently been studied, and there is little information about how coral communities are distributed and how rare they may be. This study is designed to address that shortfall.

Deepwater Shipwreck

The study report, *Viosca Knoll Wreck: Discovery and Investigation of an Early Nineteenth-Century Wooden Sailing Vessel in 2,000 Feet of Water* (Church and Warren, 2008), details the visual study of a wooden-hulled shipwreck discovered near the Petronius oil platform in the GOM. The study was performed by analyzing hours of video acquired using a remotely-operated vehicle. The identity and nationality of the vessel remains unknown, but the researchers concluded from the visual analysis of the hull remains that the ship was most likely a two-masted brig, brigantine, or schooner dating from the first quarter of the nineteenth century. The hull of the vessel is sheathed in copper or a cupreous alloy, which accounts for the wreck's state of preservation. In addition to the hull, substantial remains of the standing rigging survive, lying along the starboard side. Few artifacts could be identified from the video alone, but one significant find included the discovery of a rare ship's stove. The bow of the wreck is partly intact, but the stern is disarticulated. The site was found to have been impacted within the last decade, most likely by a large anchor cable, which is suggested by a ragged tear through the port side of the hull and a drag scar that crosses the wreck.

Subsea Processing in Deepwater Environments

The MMS study report, *Effects of Subsea Processing on Deepwater Environments in the Gulf of Mexico* (Grieb et al., 2008), represents the compilation and synthesis of existing published and unpublished literature on the environmental effects of subsea operations on the deepwater environment. Subsea processing technologies that are currently being implemented in deep water include multiphase pumps (Type 1) and partial separation with pumping (Type 2). Technologies being developed for future application include combinations of separators, scrubbers, and pumps that allow complete separation of production stream at the seabed (Type 3). The most advanced systems (Type 4) are likely to include multistage separation and fluid treatment with the production of export quality oil and gas. The primary difference between surface and subsea technologies is the restricted ability to detect and respond to releases in the deepwater environment and the extreme temperatures and pressures on the seafloor. A key technological and environmental issue involved in the implementation of subsea separation is the handling and disposal of produced waters and sands. Options include transport to the surface, reinjection into depleted formations, or discharge to the ambient environment. The potential impacts and major environmental concerns associated with subsea operations are similar to those observed with existing technologies. These include the release of drilling fluids and untreated drill cuttings during exploration and production; the catastrophic release of large volumes of hydrocarbons or utility fluids due to failures in piping, seals, and connections; and the release of untreated produced water and sands. The difference between existing and subsea technologies is the restricted ability to detect and respond to these releases in the deepwater environment. The advent of subsea technologies also introduces new environmental issues. These include the existence of large temperature differences between operating equipment and ambient conditions, the use of new treatment chemicals, the creation of electromagnetic fields associated with the operation of pumps and other equipment on the seafloor, and noise. The potential toxic effects of new or significantly modified products for treating the production and processing flow streams on benthic and free-swimming organisms should be determined. The deeper water habitats also exhibit unique features that should be considered in regulating subsea processing. For example, the presence of methane hydrates in the seafloor sediments should be identified in advance of subsea development activities. New protocols for assessing the existence, distribution, and ecological significance of benthic communities in these habitats are required.

DRILLING AND DEVELOPMENT

HURRICANE SAFETY-RELATED NOTICES TO LESSEES AND OPERATORS

The MMS continually evaluates its regulations to determine which ones need revisions or clarifications. The MMS published 25 new Notices to Lessees and Operators (NTL's) in 2008; over 25 percent of the NTL's focus on drilling, development, and/or production concerns. The effects of Hurricanes Ivan, Katrina, and Rita during the 2004 and 2005 hurricane seasons were detrimental to oil and gas operations in the GOM. These effects included structural damage to fixed production facilities, semisubmersibles, and jack-up rigs. The MMS is concerned about the loss of these facilities and rigs and the resultant pollution from future storms. In an effort to reduce these effects, real and potential, MMS has set forth guidance, through NTL's, to improve performance and safety during hurricanes.

NTL 2008-G09 ("Guidelines for Moored Drilling Rig Fitness Requirements for Hurricane Season") (USDOI, MMS, 2008c) provides guidance on the information that operators should submit with either Form MMS-123, Application for Permit to Drill (APD), or Form MMS-124, Application for Permit to Modify (APM), to demonstrate that a moored drilling rig is fit to operate at a specific location during hurricane season. The MMS used this information, along with a risk-based assessment program, to calculate an in-depth risk analysis, which compared the probability of failure with the consequence of failure. This allowed MMS to produce detailed assessments and make consistent decisions with respect to mooring requests.

In 2008, MMS evaluated 63 requests for mooring location approval during hurricane season. Thirty-five of these mooring requests were approved as-is, 25 were approved with a condition that requires the operator to move off location during the peak of hurricane season or change some of the mooring equipment to mitigate the risk involved, 2 requests were denied, and 1 was a preliminary review. The success of this program is evident by the fact that 14 moored rigs were in the path of hurricane-force winds during the 2008 hurricane season, but only 2 lost station-keeping ability. This represents only 14 percent of the moored rigs going adrift in 2008 versus the 63 percent that went adrift in 2005. The 2 rigs that did lose station-keeping did not cause any damage to critical infrastructure such as pipelines, wellheads, or platforms, which highlights the other advantage of the detail assessment program. The MMS and the drilling community are constantly working to ensure that no rigs go adrift during a hurricane, but major advancements have been made to reduce both the probability and consequence of failure in the past 3 years.

The MMS's Office of Structural and Technical Support (OSTS) has also utilized NTL's to instruct operators how to conduct assessments of their fixed and floating production facilities in response to the updated metocean criteria published in API Bulletin 2INT-MET, "Interim Guidance on Hurricane Conditions in the Gulf of Mexico" (API, 2007a). NTL 2007-G27 ("Assessment of Existing OCS Platforms and Related Structures for Hurricane Conditions") (USDOI, MMS, 2007) provides guidance on how to assess certain existing OCS platforms and related structures to ensure their structural integrity. The NTL requires that facilities meeting specific requirements [e.g., any platform that is subject to the Platform Verification Program or installed in water depths greater than 400 ft (122 m)] conduct an assessment by performing an Ultimate Strength Analysis in accordance with Section 3.3 of API Bulletin 2INT-MET. Section 9 of the same bulletin requires the operator to carry out a site-specific study of the hurricane metocean conditions.

The operators of existing floating platforms were asked to conduct an assessment using a three-step process outlined in API Bulletin 2INT-EX, "Interim Guidance for Assessment of Existing Offshore Structures for Hurricane Conditions" (API, 2007b). The assessment included a design level check, survival check, and a robustness check.

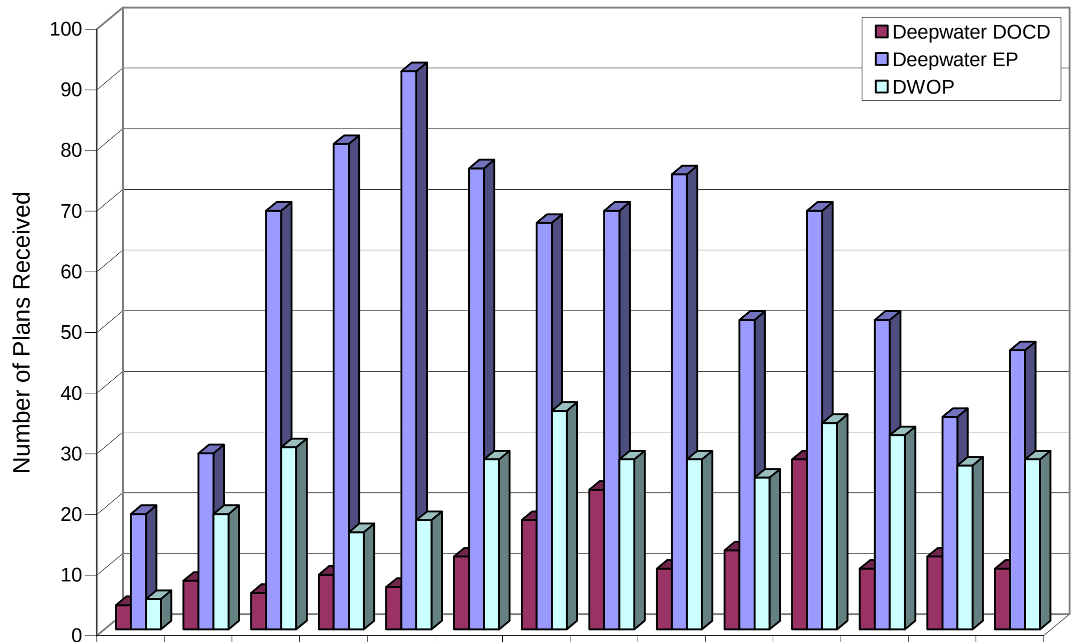
Operators of 92 platforms that were identified as Central Region, high-consequence facilities were required to submit the results of the platform assessments by June 1, 2008. Operators of the platforms that were deemed not to be in compliance with the updated metocean criteria were also required to submit a mitigation plan to bring the facility into compliance. Currently, the OSTS is reviewing the assessments submitted by each operator and will conduct a review of the mitigation plan to ensure that all the appropriate steps are being taken to bring the platforms into compliance.

PLANS

The NTL's play an important role in MMS's ability to communicate with industry and therefore require a significant amount of time and effort be dedicated to their development, but substantially more energy is focused on reviewing and approving plans submitted by operators on a daily basis. **Figure 12** shows the number of deepwater Exploration Plans (EP's), deepwater Development Operations Coordination Documents (DOCD's), and Deepwater Operations Plans (DWOP's) received each year since 1995. The number of EP's, DOCD's, and DWOP's includes only the initial plans, not revisions or supplements to plans. In addition, the number of DWOP's received includes only initial Conceptual Plans or combined Conceptual Plans/DWOP's as allowed by the revised 30 CFR 250 Subpart B regulations. The MMS requires DWOP's for developments in water depths greater than 1,000 ft (305 m) and Conservation Information Documents (CID) for developments in water depths greater than 1,312 ft (400 m). Some shallow-water activities are included in the data because all subsea developments, regardless of water depth, must file a DWOP.

The MMS has found the number of plans received to be a useful indicator in projecting activity levels. Although the order of plan submission and drilling activities can vary with projects, operators generally proceed as follows:

- File an EP
- Drill exploratory wells
- File a Conceptual Plan
- File a DOCD and CID
- File a DWOP
- Install production facilities
- Drill development wells
- Begin first production



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Deepwater DOCD	4	8	6	9	7	12	18	23	10	13	28	10	12	10
Deepwater EP	19	29	69	80	92	76	67	69	75	51	69	51	35	46
DWOP	5	19	30	16	18	28	36	28	28	25	34	32	27	28

Figure 12. Deepwater EP's, DOCD's, and DWOP's received since 1995.

There was a marked increase in EP's, DOCD's, and Conceptual Plans or combined Conceptual Plans/DWOP's from 1996 to 1999. Submittals of EP's reached a peak of 92 in 1999 and then hovered near 70 per year until 2004. The number of DOCD submittals reached a high of 28 in 2005 and has leveled off near 10 submittals from 2006 to 2008. There was an increase in the number of initial Conceptual Plans or combined Conceptual Plans/DWOP's submitted from 2004 to 2006 (from 25 to 32) and has averaged just fewer than 30 submittals in 2007 and 2008. From 2006 to 2008 all three types of plans leveled off in between the high and low values for the past 13 years.

In addition to the 28 initial Conceptual Plans and combined Conceptual Plans/DWOP's MMS received in 2008, nine supplemental plans were also received that were not included in the totals above. Also not included in the totals above are 29 initial/supplemental DWOP's (formally Preliminary DWOP's), 17 of which were supplemental. Supplemental plans are often submitted when an operator wants to tie additional wells into a previously approved subsea system or wants to make a modification to the initial plan, such as waterflood, gas lift, or subsea pumping, that was not initially approved. The high number of supplements indicates that operators are not only looking to increase production from new developments but also from existing developments.

RIGS

Figure 13 depicts the maximum number of deepwater rigs operating in the GOM for any 1 month period during any 1 year. After a peak in 2001, the number of rigs declined through 2005, followed by a slight increase in 2006, and has remained steady until 2008. It should be noted that this figure includes platform rigs and MODU's.

Figure 14 shows the approximate number of deepwater MODU's, by water-depth categories, that were contracted to the GOM and worldwide (outside of the GOM) in 2008. Approximately 53 percent of MODU's worldwide (not including the GOM) were capable to drill in water depths of 1,500 to 4,999 ft (457 to 1,524 m). In the GOM, approximately 22 percent were capable of drilling in this same water depth range. There is a comparatively larger percentage of rigs within the GOM capable of drilling in water depths greater than 7,500 ft (2,286 m) compared with worldwide, 44 percent to 19 percent. Overall, approximately 21 percent of the worldwide, deepwater fleet are contracted to the GOM.

The reader is cautioned not to draw conclusions from the rig count differences between **Figures 13** and **14**. **Figure 13** includes platform rigs in addition to MODU's and only considers rigs which were in operation; **Figure 14** addresses only MODU's. Also, the total number of rigs in **Figure 14** has increased significantly since the 2008 Deepwater Report (Richardson et al., 2008) because of the availability of rig data from additional operating companies. Further, not all MODU's in **Figure 14** are operating at any given time, and upgrades to MODU's that increase their water-depth capability will alter the maximum water-depth rig counts show; consequently, year-to-year comparisons are even more difficult to make.

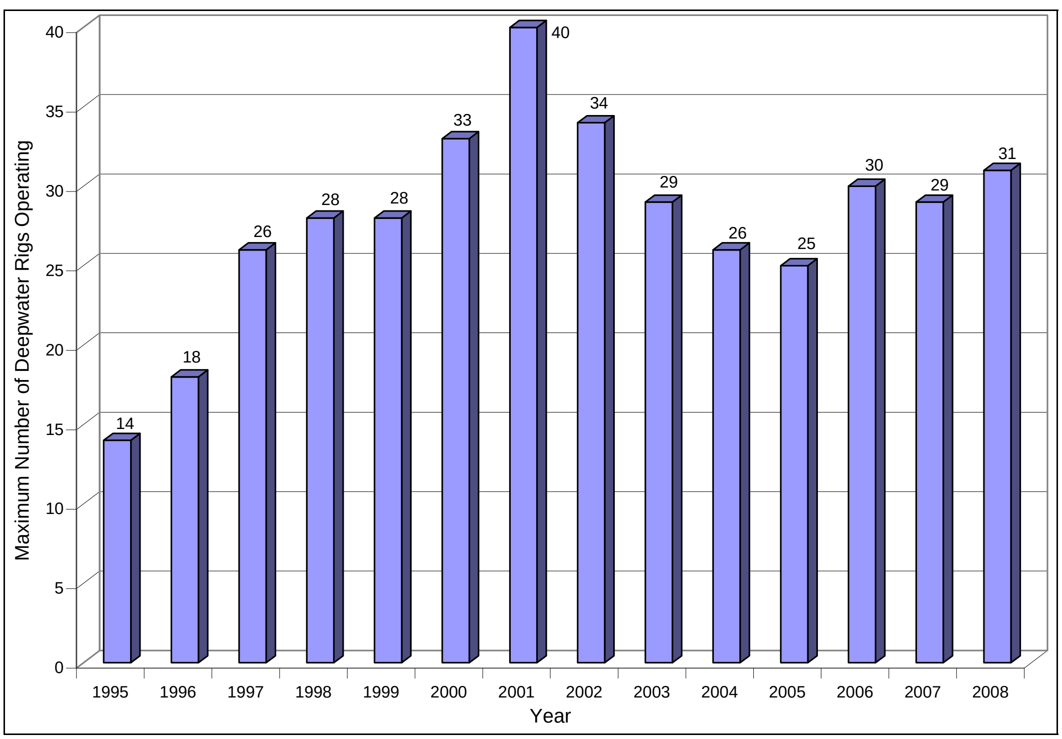


Figure 13. Maximum number of platform rigs and MODU's operating in the deepwater Gulf of Mexico in any one year.

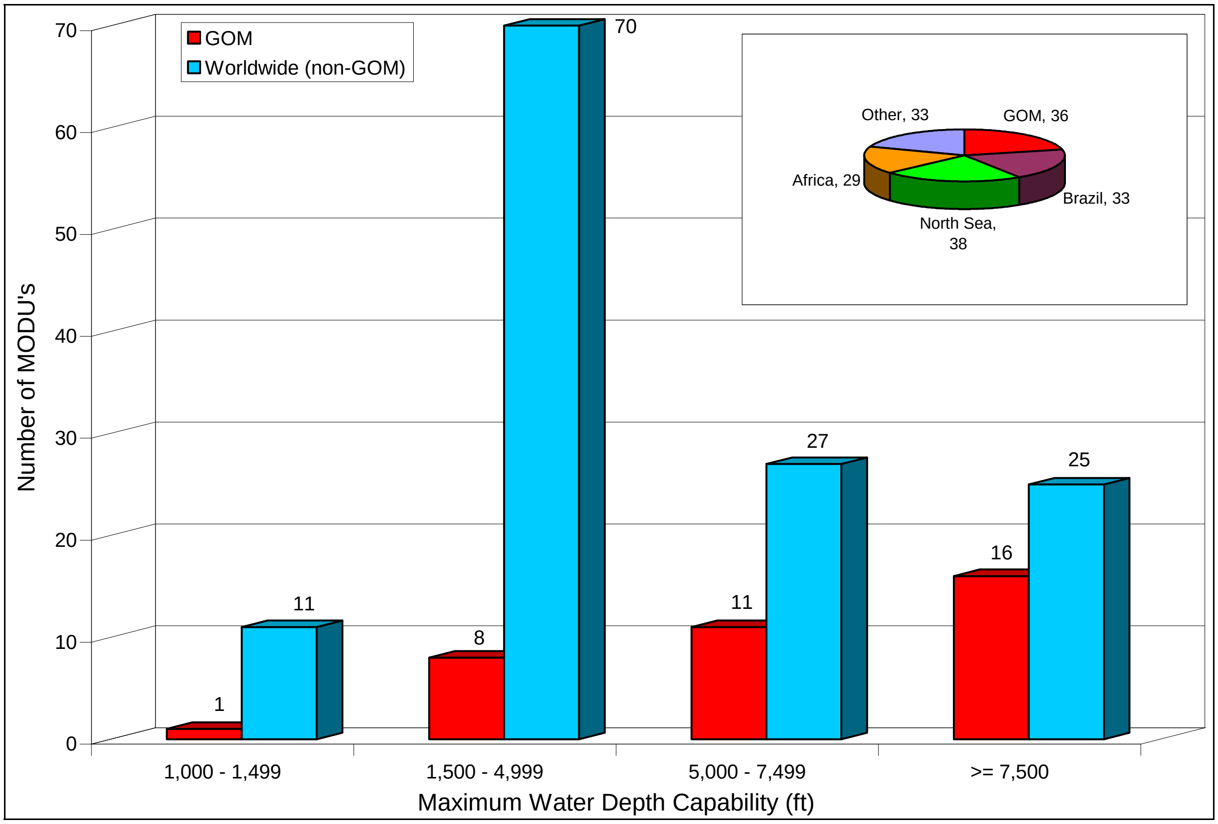


Figure 14. Approximate number of deepwater MODU's contracted to the Gulf of Mexico and worldwide subdivided according to their maximum water-depth capabilities. Inset shows the number of deepwater MODU's in various locations.

DRILLING ACTIVITY

Figure 15 shows the number of deepwater wells drilled from 1992 through 2008 by water depth category. In 2008, 108 wells were spudded in water depths greater than 1,000 ft (305 m); nearly 80 percent of the wells were for exploration. Ten of the total wells drilled were in water depths greater than 7,500 ft (2,286 m). The number of wells drilled generally increased from 1992 through 2001. Conversely, there has been a general decline for the last 7 years. Active hurricane seasons influenced the lower number of wells spudded in 2005 and 2008.

Only original boreholes and sidetracks (a new bottomhole location) are included in the well counts used in this report. Wells defined as "by-passes" are specifically excluded. A "by-pass" is a section of well that does not seek a new objective; it is intended to drill around a section of the wellbore made unusable by stuck pipe or equipment left in the hole.

Figures 16 and **17** further delineate the deepwater well counts into exploratory and development wells, respectively. This report uses the designation of exploratory and development wells provided by the operators. The data reflect the variations among operators in classifying wells as either development or exploratory. **Figure 16** shows that after decreasing in 2002 and 2003, the number of exploratory wells drilled increased through 2006 and has shown a slight downward trend since then. Exploratory drilling in the 1,500- to 4,999-ft (457- to 1,524-m) water-depth range remained nearly the same from

2002 through 2004, but increased in 2005 and remained relatively level through 2007. The number of wells drilled in 2008 has decreased slightly. From 2005 to 2006, the number of wells drilled in the 5,000- to 7,499-ft (1,524- to 2,286-m) water-depth range nearly doubled, and it has remained level through 2008. In 2008, Murphy drilled a discovery, Diamond, in the Lloyd Ridge Area in 9,975 ft (3,040 m) of water. This represents the third deepest water depth for an exploratory well in the GOM.

Figure 17 shows that overall there has been a decrease in the number of development wells drilled from 2002 through 2005. Possible reasons for the decrease may be the method by which wells are categorized in this report (exploratory versus development), the retention of exploratory wells for production purposes, and the lag from exploration to first production. The complexity of developments in ultra-deep water may also be a factor, requiring operators to spend more time in planning and design. The total number of development wells increased in 2006 and 2007. The remarkable increase in the total number of development wells drilled in 2007 in the greater than 7,500-ft (2,286-m) water-depth interval is mostly associated with the Perdido Regional Host facility. The number of wells drilled in 2008 has dropped back to 2005 levels. In 2008, Shell Oil Company set a world water depth record in drilling and completing a subsea well 9,356 ft (2,852 m) below the GOM's water surface in the Silvertip project at the Perdido Regional Host facility in Alaminos Canyon.

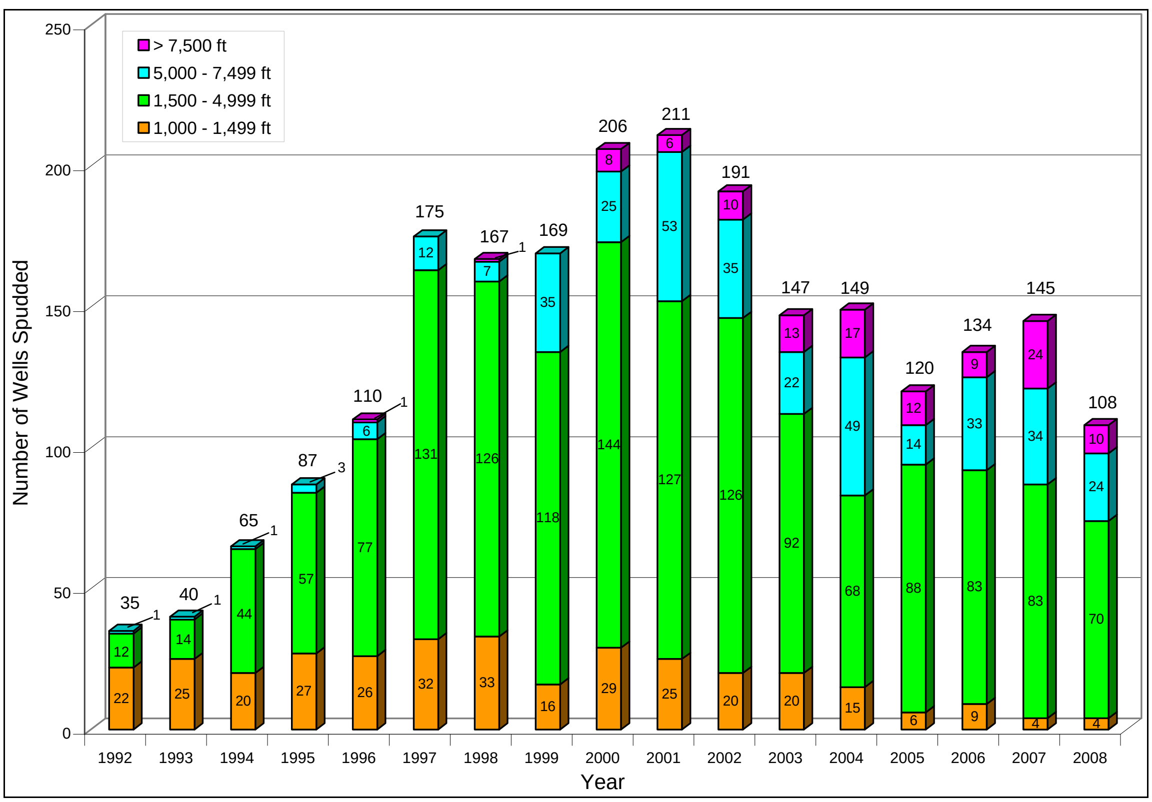


Figure 15. All deepwater wells drilled subdivided by water depth.

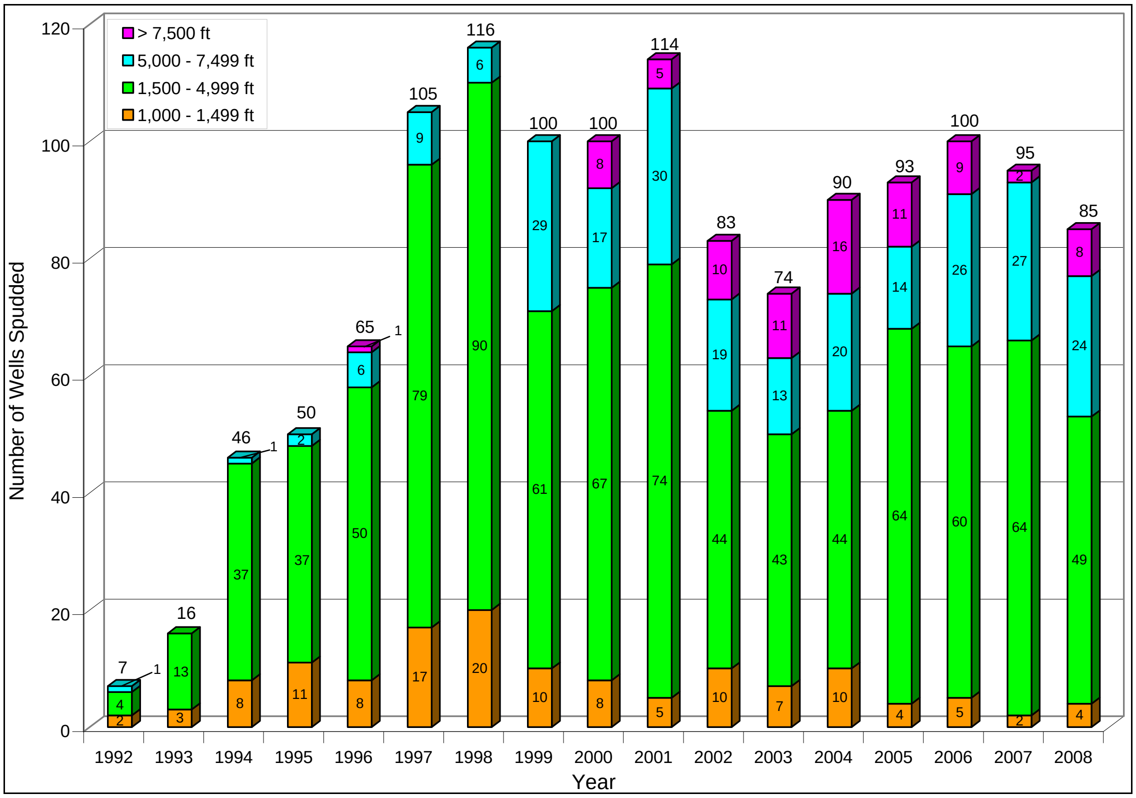


Figure 16. Deepwater exploratory wells drilled subdivided by water depth.

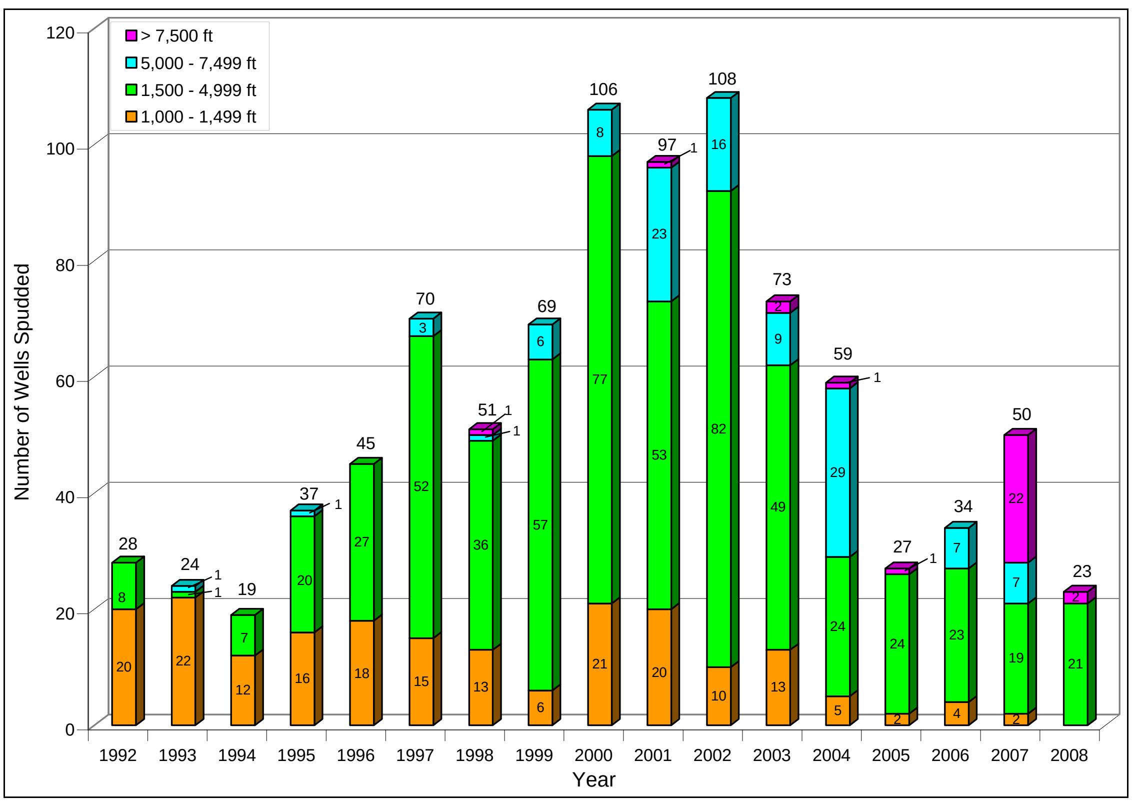


Figure 17. Deepwater development wells drilled subdivided by water depth.

DEVELOPMENT SYSTEMS

Development strategies vary for deep water, depending on reserve size and distribution, proximity to existing infrastructure, operating considerations (such as well interventions), prior company expertise with similar structures, economic considerations, and an operator's interest in establishing a production hub for the area. **Appendix A** lists the systems that have begun production in the deepwater GOM, and **Figure 18** shows the location of existing deepwater structures by type. Fixed platforms (e.g., Bullwinkle) have economic water-depth limits of about 2,000 ft (610 m). Compliant towers (e.g., Petronius) are usually deployed in water depths of approximately 1,000 to 2,000 ft (305 to 610 m). Tension-leg platforms (TLP's) (e.g., Brutus, Magnolia, Marco Polo, and Shenzi) are frequently used in 1,000- to 5,000-ft (305- to 1,524-m) water depths. Spars (e.g., Genesis, Red Hawk, Tahiti, and Perdido); semisubmersible production units (e.g., Na Kika and Blind Faith); FPU's (e.g., Phoenix); and FPSO's (e.g., Cascade and Chinook) may be used in water depths ranging up to and beyond 10,000 ft (3,048 m).

Subsea systems are capable of producing hydrocarbons from reservoirs covering the entire range of water depths that industry is exploring. They range in complexity from a single subsea well producing to a nearby fixed platform, TLP, or floating production system (FPS), to multiple wells producing through a manifold and pipeline system to a distant production facility. Subsea systems continue to be a key component in the success in deep water to date. In fact, approximately 290 productive wells in deep water are subsea.

INDUSTRY INVOLVEMENT AND NEW TECHNOLOGIES

The year 2008 has seen a revived effort for MMS and members of industry to work collectively on research and guidance documents that will provide valuable information for future developments. The MMS was involved in over 35 API committees in 2008. API Recommended Practice (RP) 2SK ("Design and Analysis of Station Keeping for Floating Structures") (API, 2008), API RP 2SM ("Design, Manufacture, Installation, and Maintenance of synthetic Fiber Ropes for Offshore Mooring") (API, 2007c), API RP 17O ("High Integrity Pressure Protection Systems") (API, in preparation a), API RP 17G ("Completion/Workover Risers") (API, in preparation b) and the new high-pressure/high-temperature committee [now named PER 15K ("Protocols for Equipment Rated Greater Than 15,000 PSI")] are a few of the committees in which MMS has been actively involved. These documents will pave the way for the acceptance of new technologies and practices as industry moves to develop prospects in a more challenging environment.

Another key initiative between MMS and industry, which is designed to increase the collective understanding of the challenges in the near future and investigate potential solutions, was undertaken by MMS's Technology Assessment and Research program. In 2008, MMS commissioned almost $2 million dollars worth of Operational Safety and Engineering Research projects. Most notably, MMS contracted 29 research projects, many co-funded with other U.S. and international governments or private organizations, focusing on the safety of oil and gas development, alternative energy initiatives, and oil-spill response. Eight of these projects specifically focused on high-pressure/high-temperature concerns, preventing hybrid well failures, and analyzing gas pipeline ruptures. An additional four projects will look into alternative energy design standards and inspection criteria, and three projects will concentrate on Arctic exploration and production. More

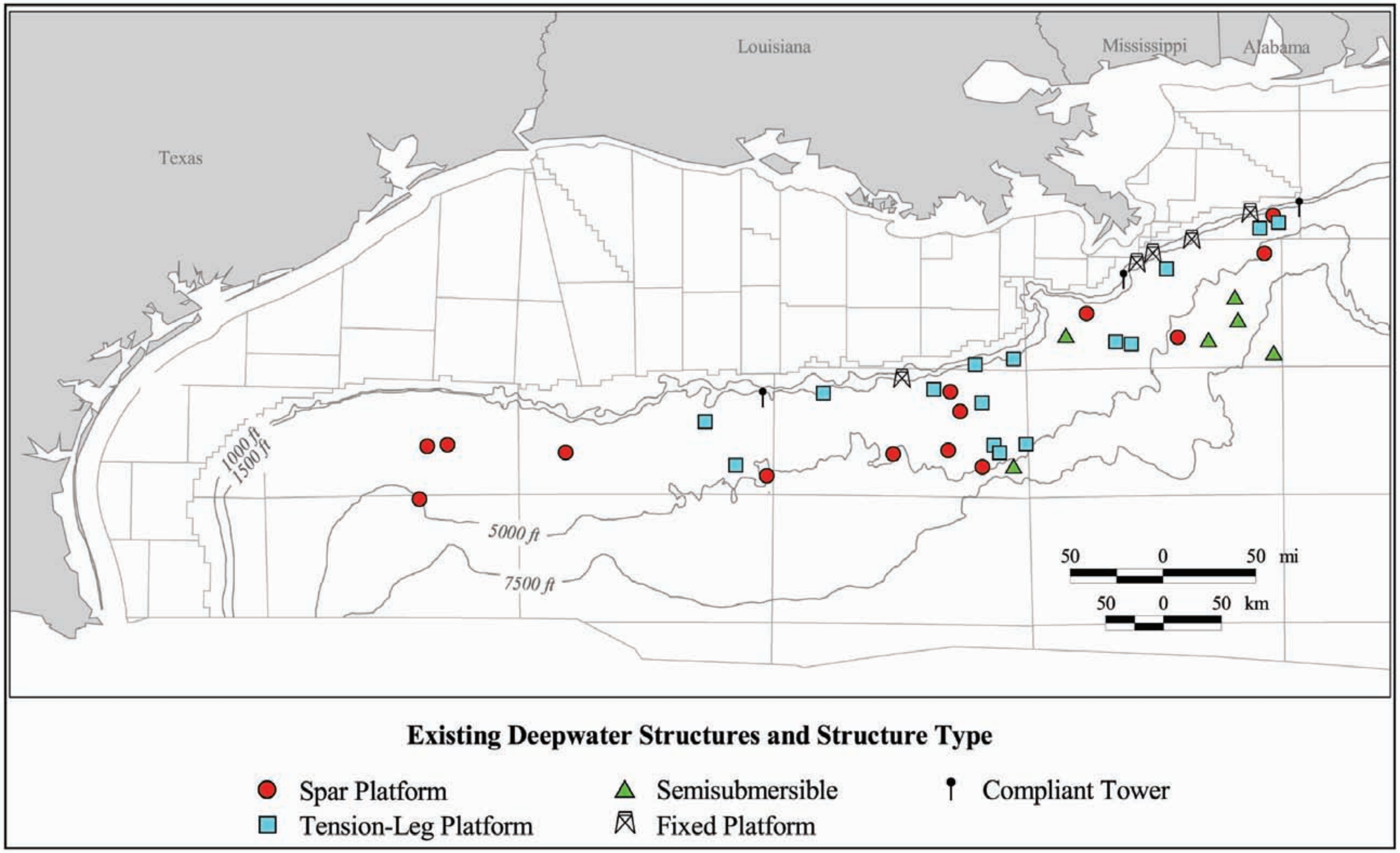


Figure 18. Location map of currently installed deepwater structures by type.

information on deepwater research projects can be found at MMS's Web site at http://www.mms.gov/tarprojectcategories/deepwate.htm.

The MMS has leveraged the information obtained from these industry meetings and research projects to work with operators on the evaluation and installation of new technologies for their deepwater developments. Shell Exploration and Production Company's (Shell) Perdido Regional Host facility located in Alaminos Canyon Block 857, Petrobras America's Inc (Petrobras) Cascade and Chinook developments located in Walker Ridge Block 206 and 469, respectively, and Energy Resource Technology's Phoenix development located in Green Canyon Block 237 are just a few examples of how the increased communication between industry and MMS are leading to exciting new developments.

Perdido

The Perdido Spar is located 200 mi (322 km) south of Houston, Texas. The truss spar sets a new record as the deepest spar in the world at over 8,000 ft (2,438 m) of water. Once the development is complete, the spar will have 130,000 barrels of oil equivalent per day (BOE/d) capacity and will accept production from 34 wells, 22 direct vertical access (DVA) subsea wells, and 12 remote subsea wells from the Great White, Silvertip, and Tobago projects. Because of the remote location of the facility in Alaminos Canyon Block 857, 77 mi (124 km) of oil export and 107 mi (172 km) of gas export pipeline will be installed with the facility. The Spar was installed in August 2008, and the topsides were installed in March 2009, with first oil around the turn of the decade.

Shell has extended the limits of existing technology and practices to enable development in this ultra-deepwater environment. Perdido represents the first application of full, host-scale subsea separation and boosting, which enables improved recovery by removing about 2,000 pounds per square inch (psi) of back pressure from the wells.

The electric submersible pump (ESP)-caisson subsea separation and boosting system utilizes a caisson jetted approximately 300 ft (91 m) into the seafloor and a large ESP to lift fluids approximately 8,000 ft (2,438 m) to the host processing fluid. The subsea separator is configured to utilize cyclonic separation to separate oil and water from the gas phase. The separation will occur at the mudline, with liquid pumped via the ESP to the surface in an inner tubing string, while the gas free flows to the surface in the annulus. This scheme will enable improved recovery and longer well life while also mitigating the risk of hydrates in the system.

Perdido is also the first application of wet tree DVA wells. The wet tree DVA concept enables a small host design while enabling a high well count that can be phased in over time utilizing a platform-based drilling rig.

Cascade and Chinook

Petrobras is poised to bring the first FPSO system to the U.S. GOM in early 2010. Because of the ability of the FPSO to perform in extreme water depths and equally extreme distances from shore, Petrobras' project, located in the Walker Ridge Area, 165 mi (266 km) offshore, is an ideal location for the FPSO system. The vessel chosen for this distinction is a converted double-hulled tanker that has been renamed the *BW Pioneer* (**Figure 19**). Modifications to the vessel commenced in March 2008 in China, with continuing modifications currently being performed in Singapore. The *BW Pioneer* will have a peak production capacity of 80,000 bo/d, 16 MMcf/d, and 16,000 barrels of water per day (bw/d).

Downstream operations will include one gas export pipeline and two dedicated shuttle tankers for oil. Each shuttle tanker will be Jones Act compliant vessels with a storage capacity of 300,000 barrels (bbl). Unique to the *BW Pioneer* is a detachable turret buoy through which all production flows. The ability to detach during a hurricane or named storm will allow the self-propelled *BW Pioneer* to motor into safe waters, allowing the storm to pass, then moving back into position, reattaching to the buoy and resuming production with as little downtime as possible. In addition to the FPSO, detachable turret buoy, and shuttle tankers for oil export, Petrobras' project will utilize three other technologies considered new to the GOM, including free-standing hybrid risers, polyester mooring, and electric submersible booster pumps.

In April 2008, MMS issued a press release (USDOI, MMS, 2008d) announcing the approval of a DOCD for the project. A DOCD outlines the operational plan for developing a project, including timelines for drilling wells and installing production facilities as well as geological and geophysical information. The document also identifies any specific environmental issues that must be addressed, including safety and pollution prevention. The next step in the development process is the MMS review of Petrobras' DWOP. The plan, which is expected to be received in early 2009, must be approved before production can commence.

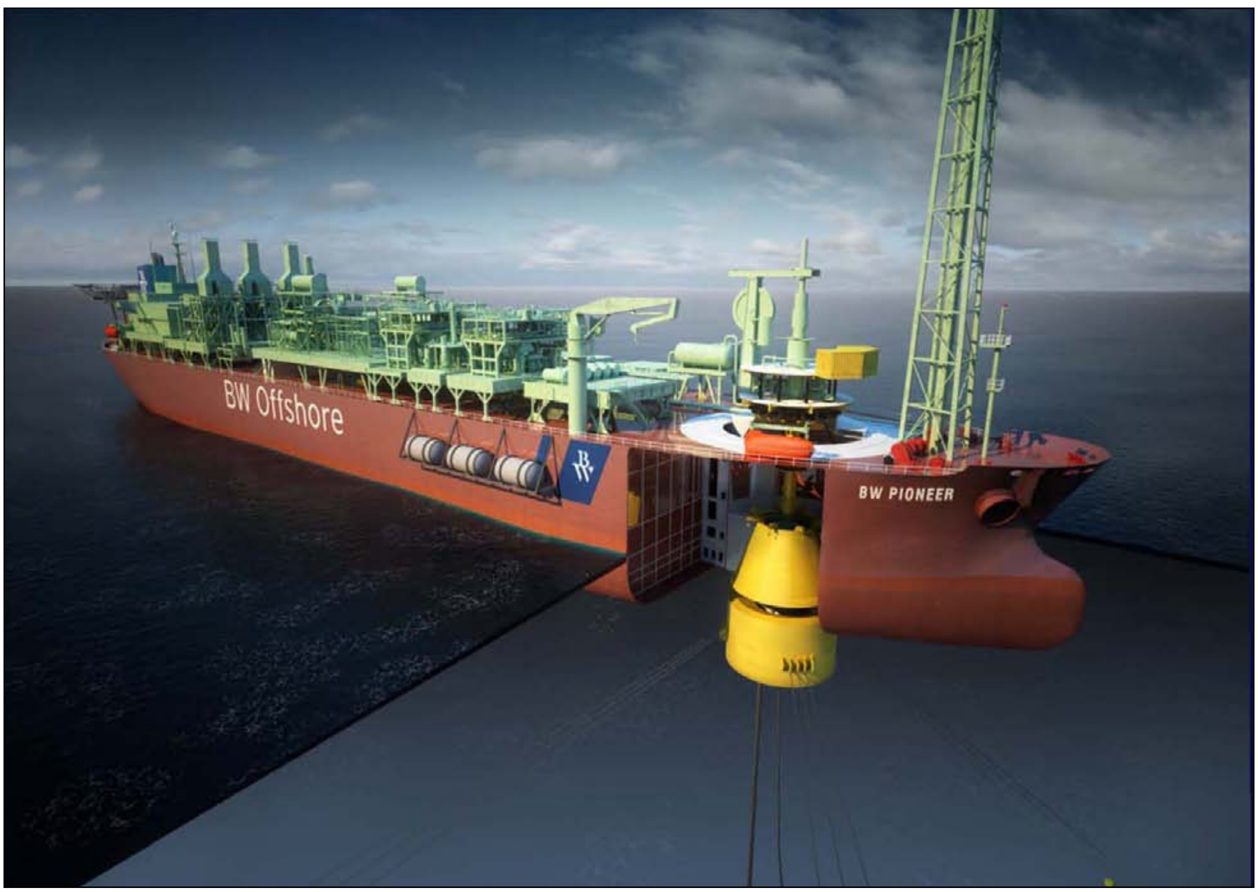


Figure 19. The *BW Pioneer*, the double-hulled tanker that will serve as the FPSO for the Cascade and Chinook developments. (Depiction courtesy of Petrobras.)

Phoenix

Energy Resource Technology acquired the Typhoon Field in August 2006 following the loss of the Chevron operated TLP in Green Canyon Block 237. Energy Resource Technology contracted Helix to provide an FPU named *Helix Producer I* (**Figure 20**) for redevelopment of the newly renamed Phoenix Field. The *Helix Producer I* is designed to serve smaller fields in deep water and can also be used as an early production test vessel. The *Helix Producer I* vessel is a dynamically positioned FPU with a detachable buoy that can quickly disconnect and sink to a water depth of 130 ft (40 m). This allows the vessel to move away from adverse sea conditions. The ability to move away from a storm with personnel on board offered many safety advantages over existing deepwater facilities. A disconnectable transfer system (DTS) (**Figure 21**) was designed and built by Flexible Engineered Solutions to attach the *Helix Producer I* to the subsea wells in the Phoenix Field. Although the DTS had been previously used in Asia, the concept was a first for the U.S. GOM. Energy Resource Technology has worked with MMS and Flexible Engineered Solutions to provide a system that meets or exceeds the operating requirements for the GOM.

Helix Producer I is currently completing vessel system commissioning in Neorion Shipyard in Syros, Greece. The vessel will arrive in Kiewit Offshore Services in Ingleside, Texas, in May 2009. The DTS will be connected to the hull, and topside process modules will be installed on the vessel. The vessel will sail to Green Canyon Block 237 during the fourth quarter of 2009 and begin riser pull in. Once the *Helix Producer I* vessel has demonstrated to United States Coast Guard and MMS that operation of the DTS and Certificate of Compliance have been achieved, Energy Resource Technology will commence production.

The developments and associated new technologies mentioned above are just a few that have been reviewed by MMS's petroleum and structural engineers. Approval can be granted only after significant research and hazard analyses are conducted. The engineers considered many different conditions that can exist offshore and also confirmed that there was a proven effective method to shut-down operations in the case of a failure.

Figure 20. The *Helix Producer I*, a conventional ship-shape floating production unit. (Photo courtesy of Helix Energy Solutions.)

Figure 21. Disconnectable transfer system to attach the *Helix Producer I* to the subsea wells in the Phoenix Field. (Photo courtesy of Helix Energy Solutions.)

Thunder Horse

Another exciting development that will significantly contribute to our national oil and gas reserves is British Petroleum Exploration and Production, Inc's Thunder Horse. The Thunder Horse platform is located about 150 mi (241 km) southeast of New Orleans in Mississippi Canyon Block 778 at a water depth of approximately 6,050 ft (1,844 m) and is the largest semisubmersible facility in the world at 130,000 tonnes (143,300 U.S. tons) displacement and has a deck load capacity of 40,000 tonnes (44,092 U.S. tons). Production is from reservoirs between 14,000 and 19,000 ft (4,267 and 5,791 m) below the seabed, with reservoir pressures of 13,000 to 18,000 psi and reservoir temperatures of 190º to 270º F (88º to 132º C). The Thunder Horse Field is the largest producer in the GOM. As of March 20, 2009, Thunder Horse was producing approximately 260,000 bo/d and 210.5 MMcf/d from seven wells. Prior to commencing production from the seventh well, British Petroleum received approval from the MMS New Orleans district to debottleneck the topside production facilities to 275,000 bo/d and 220 MMcf/d. Oil and gas is transported to existing shelf and onshore pipelines via the Proteus and Endymion oil pipeline systems and the Okeanos gas pipeline system, which are part of the Mardi Gras Transportation System, the highest capacity deepwater pipeline system ever built. On the adjacent Thunder Horse North Field, the *Discoverer Enterprise* MODU is drilling and completing wells that will bring on additional production throughout 2009.

RESERVES AND PRODUCTION

Reserves and Discoveries

Figure 22 shows the number of deepwater discoveries each year since 1975. Since 1975 there have been at least 285 deepwater discoveries in the GOM, of which 127 have become proved fields, accounting for 11.060 BBOE of proved reserves. In an attempt to capture the impact of the deepwater exploratory successes, in addition to MMS proved reserves, unproved reserves, and resource estimates, **Figure 22** also includes publicly-available, industry-announced discoveries (IAD's). The IAD volumes contain considerable uncertainty, are based on limited drilling, include numerous assumptions, and have not been confirmed by independent MMS analyses. They do, however, illustrate recent activity better than using only MMS-proved reserve numbers.

There is often a significant lag between a successful exploration well and its hydrocarbons being produced. The success of an exploration well may remain concealed from the public for several years until the operator requests a "Determination of Well Producibility" from MMS. A successful MMS determination then "qualifies" the lease as producible and the discovery is placed in a field. The discovery date of that field is then defined as the total depth date of the field's first well that encountered significant hydrocarbons. Hydrocarbon reserves are still considered unproved until it is clear that the field will go on production. Then the reserves move into MMS's proved category.

The increase in proved reserves in 1989 is partially a result of the Mars-Ursa discoveries. Likewise, the increase in 1999 is partially a result of the Thunder Horse discovery. These two fields, located in Mississippi Canyon, represent two of the largest in the GOM based on proved barrels of oil equivalent (BOE) reserves (Crawford et al., 2008). The apparent decline of proved reserve additions in recent years is caused by the lag between discovery and development. The increase of unproved reserves, resources, and IAD's in 2006 is partially a result of the Kaskida discovery located in Keathley Canyon. In the last 2 years, oil and gas volumes added to the GOM decreased sharply from those in 2006. This is due in part to the fact that MMS has not completed volumetric estimates for 2007 and 2008 discoveries in deep water.

Production Trends

Leasing, drilling, and discoveries all stepped into deeper waters with time. Production, the final piece in the puzzle, is no exception. In 2007, approximately 70 percent of the GOM's oil production and 36 percent of its natural gas were from wells in 1,000 ft (305 m) of water or greater. **Figure 23** illustrates deepwater projects that began production in 2007 and 2008 and those expected to commence production in the next 5 years. Seven deepwater projects went online in 2008: Bass Lite and Neptune in Atwater Valley; and Blind Faith, Mississippi Canyon Block 161, Raton, Thunder Horse, and Valley Forge in Mississippi Canyon. In addition to the projects displayed on **Figure 23**, more are likely to come online in the next few years but are not shown because operators have not yet announced their plans. See **Appendix A** for a listing of all productive projects.

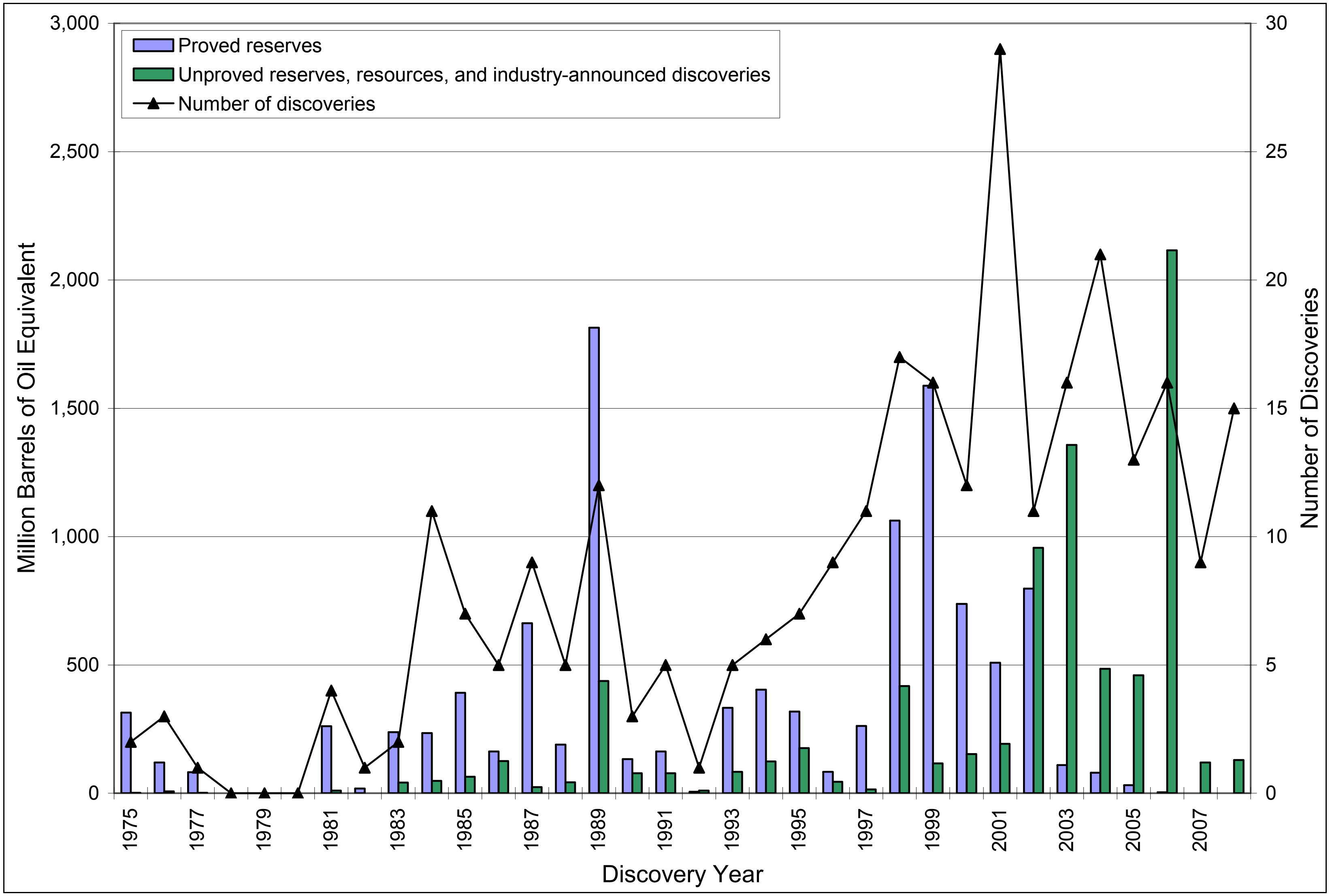


Figure 22. Number and volume of deepwater discoveries. Volumes include MMS reserves, MMS resources, and industry-announced discoveries.

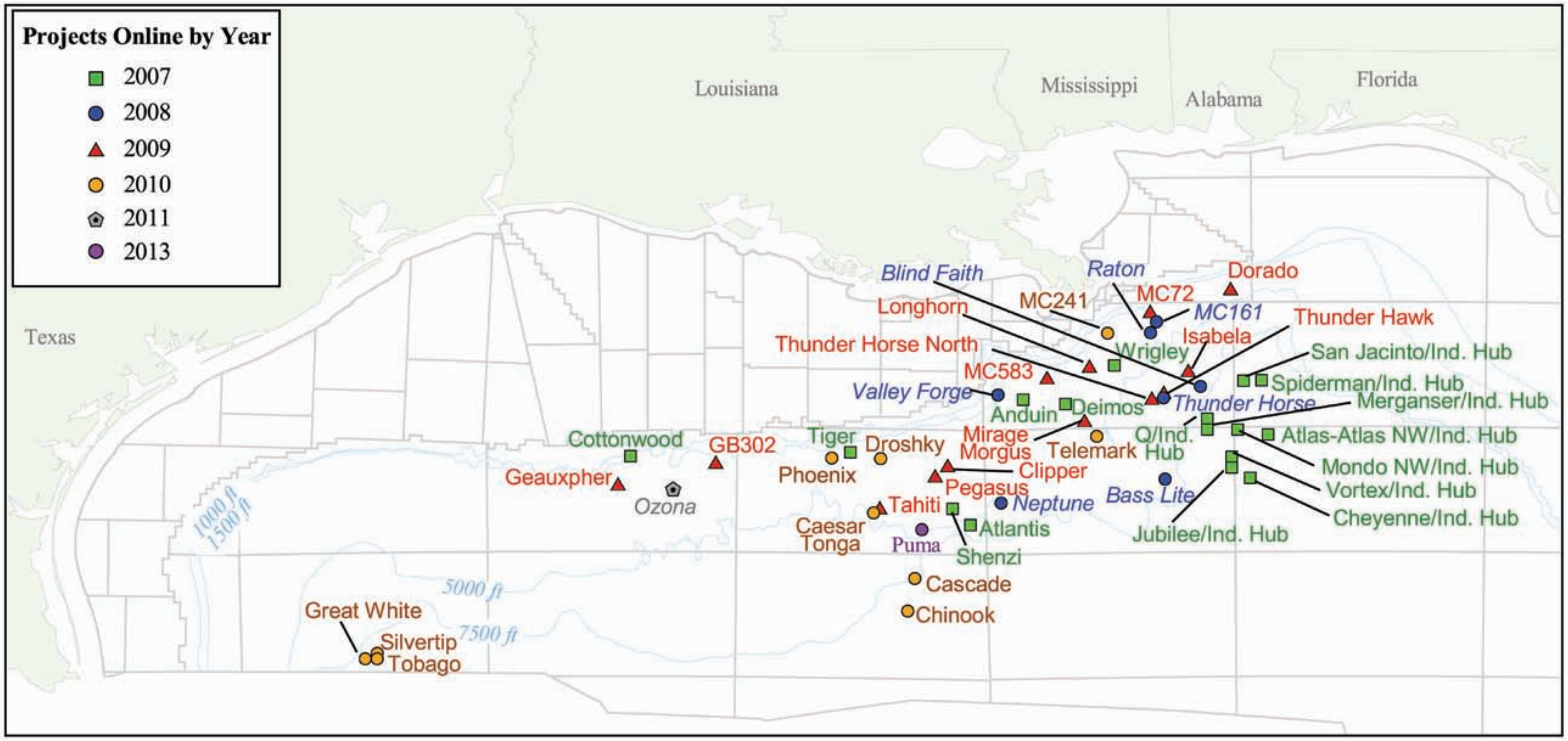


Figure 23. Deepwater projects that began production in 2007 and 2008 and those expected to begin production by yearend 2013.

Table 6 shows that the 20 most prolific producing blocks in the GOM continue to be located in deep water. The total cumulative production numbers on this table are from January 2006 through December 2007. With the onset of production from the Thunder Horse Field in 2008, it is currently the largest daily producer in the GOM. As of March 20, 2009, production was approximately 260,000 bo/d from seven wells.

Table 6. Top 20 Producing Blocks for the Years 2006-2007

Block	Project Name	Operator	Water Depth (ft)[1]	Production (BOE)[2]
MC 807	Mars	Shell	2,933	53,019,685
MC 383	Kepler (Na Kika)	British Petroleum	5,739	39,067,447
MC 809	Ursa	Shell	3,800	35,833,474
GC 782	Mad Dog	British Petroleum	4,420	29,236,814
GC 644	Holstein	British Petroleum	4,340	23,479,322
VK 786	Petronius	ChevronTexaco	1,753	22,756,704
VK 912	Ram Powell	Shell	3,216	21,399,283
GB 668	Gunnison	Kerr-McGee	3,126	19,934,221
MC 686	Mensa	Shell	5,329	19,203,737
MC 429	Ariel (Na Kika)	British Petroleum	6,240	19,035,754
GB 215	Conger	Amerada Hess	1,500	18,676,616
MC 127	Horn Mountain	British Petroleum	5,400	18,672,184
MC 765	Princess	Shell	3,642	18,228,344
MC 763	Mars	Shell	2,933	18,086,449
EB 602	Nansen	Kerr-McGee	3,580	17,605,355
GB 783	Magnolia	ConocoPhillips	4,670	15,126,505
GC 202	Brutus	Shell	2,985	14,899,369
MC 85	King	British Petroleum	5,317	14,841,496
GC 562	K2	Anadarko	3,970	12,929,509
MC 773	Devil's Tower	Eni	5,610	12,813,802

[1] Water depths are approximate and may vary depending on the location of the production facility or the location of a completed well (average of wells or deepest well site) in the block.

[2] Cumulative production from January 2006 through December 2007.

Figures 24a and 24b illustrate the importance of the GOM to the Nation's energy supply. The GOM supplied approximately 25 percent of the Nation's domestic oil and 14 percent of the Nation's domestic gas production in 2007. A significant portion (approximately 18%) of the oil volume came from the deepwater GOM. Nine projects tied back to the Independence Hub facility came online from July through October of 2007. When at peak capacity, production from the hub will add 1 Bcf/d, representing over 10 percent of the gas production from the total GOM.

Figure 25a illustrates historic trends in oil production. Shallow-water oil production rose rapidly in the 1960's, peaked in 1971, and has undergone cycles of increase and decline since then. Since 1997, the shallow-water GOM oil production has steadily declined and, at the end of 2006, was at its lowest level since 1965. It has, however, begun to increase in 2007. From 1995 through 2003, deepwater oil production experienced a dramatic increase similar to that seen in the shallow-water GOM during the 1960's, offsetting declines in shallow-water oil production. In fact, beginning in 2000, more oil has been

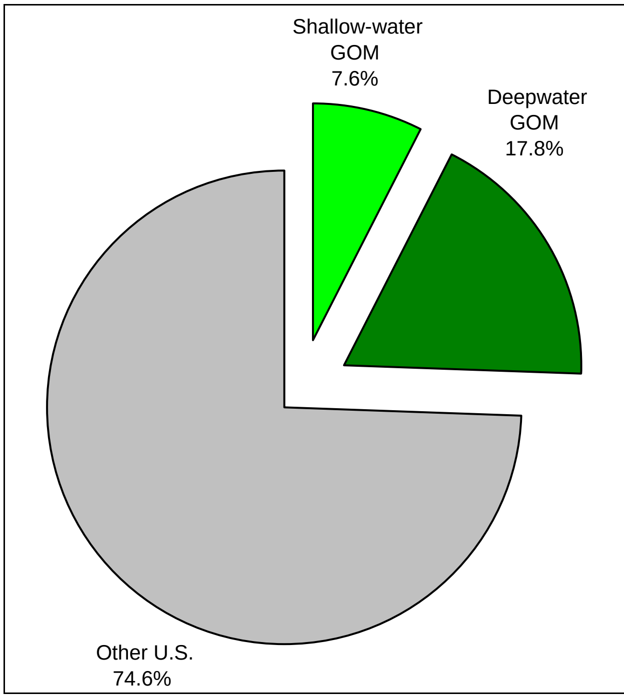


Figure 24a. Estimated U.S. oil production in 2007.

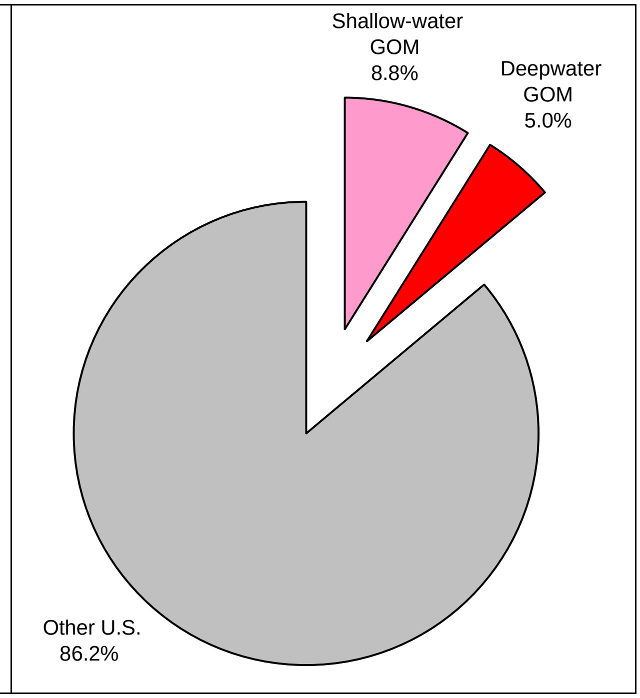


Figure 24b. Estimated U.S. gas production in 2007.

produced from the deepwater areas of the GOM than from shallow waters. Starting in 2003, deepwater oil production basically leveled off. **Figure 25b** shows similar production trends for gas. Shallow-water gas production rose sharply throughout the 1960's and 1970's, and then remained relatively stable over the next 17 years before declining steadily from 1997 through 2007. At the same time shallow-water gas production started to decline in 1997, deepwater gas production began to increase, helping to offset the declines from shallow water. Gas production from deep water has, however, declined slightly from 2003 through 2007. **Appendix B** lists historic annual GOM oil and gas production values.

PRODUCTION RATES

Figures 26a and **26b** compare maximum historic daily production rates for each lease in the GOM (i.e., the well with the highest historic production rate is shown for each lease). These maps show that many deepwater fields produce at some of the highest rates encountered in the GOM. **Figure 26a** also shows that maximum oil rates were significantly higher off the southeast Louisiana coast than off the Texas coast. **Figure 26b** illustrates the high deepwater gas production rates relative to the rest of the GOM. The relatively high gas rates from fields denoted with an asterisk are tied back to the Independence Hub facility. The hub's 1 Bcf/d capacity accounts for over 10 percent of the total gas production from the GOM. Note also the excellent production rates from the Norphlet trend (off the Alabama coast) and the Corsair trend (off the Texas coast).

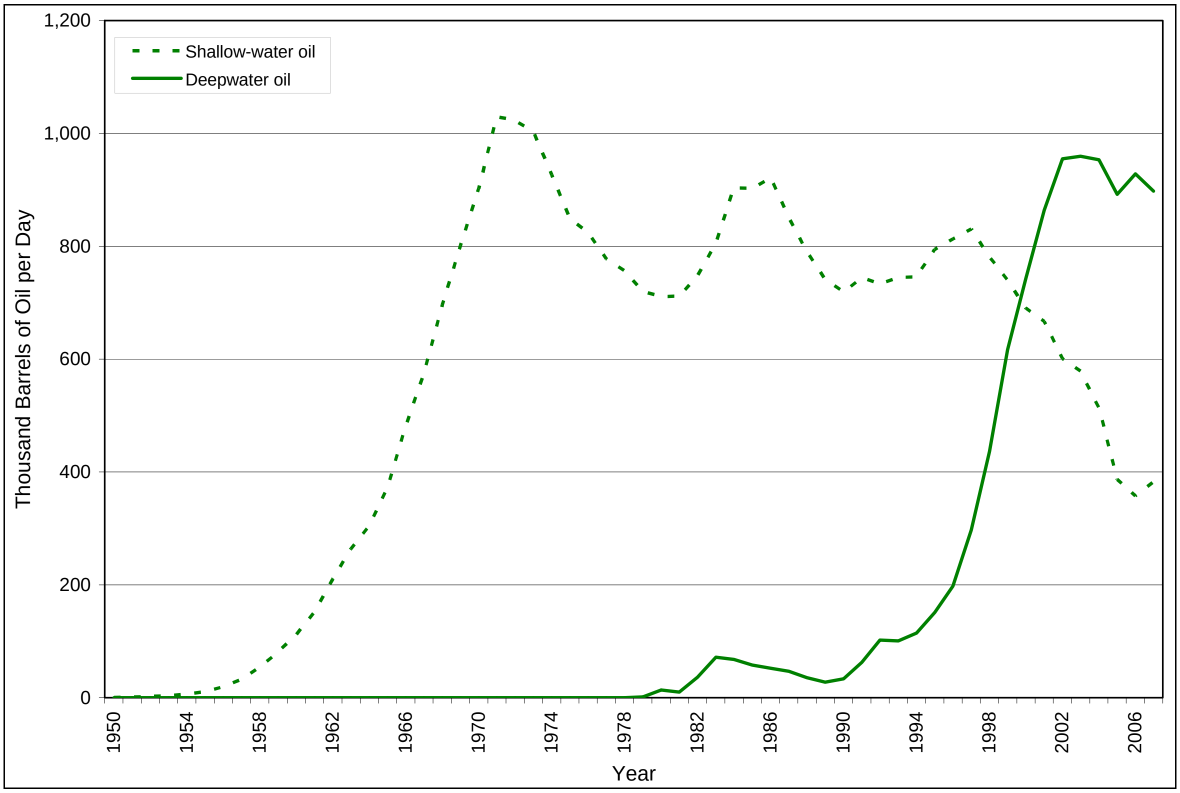


Figure 25a. Comparison of average annual shallow- and deepwater oil production.

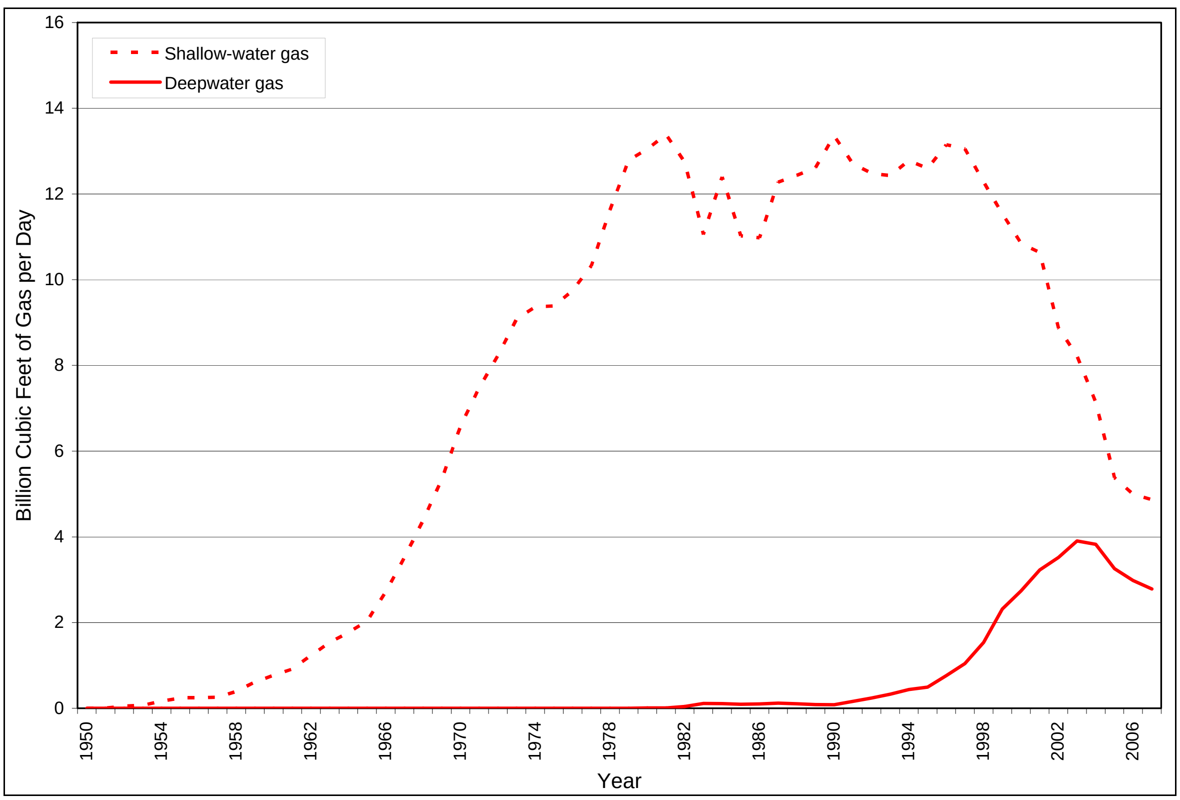


Figure 25b. Comparison of average annual shallow- and deepwater gas production.

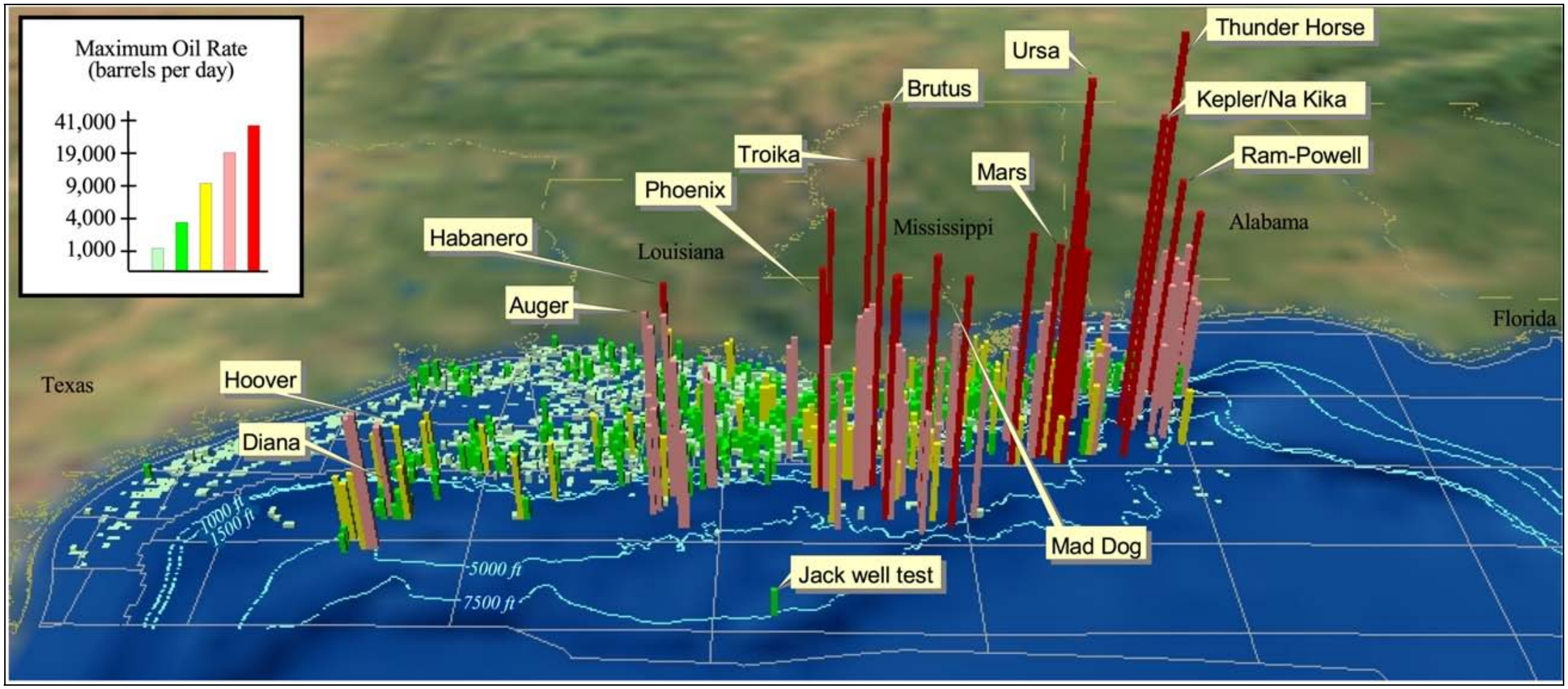


Figure 26a. Maximum historic oil well production rates.

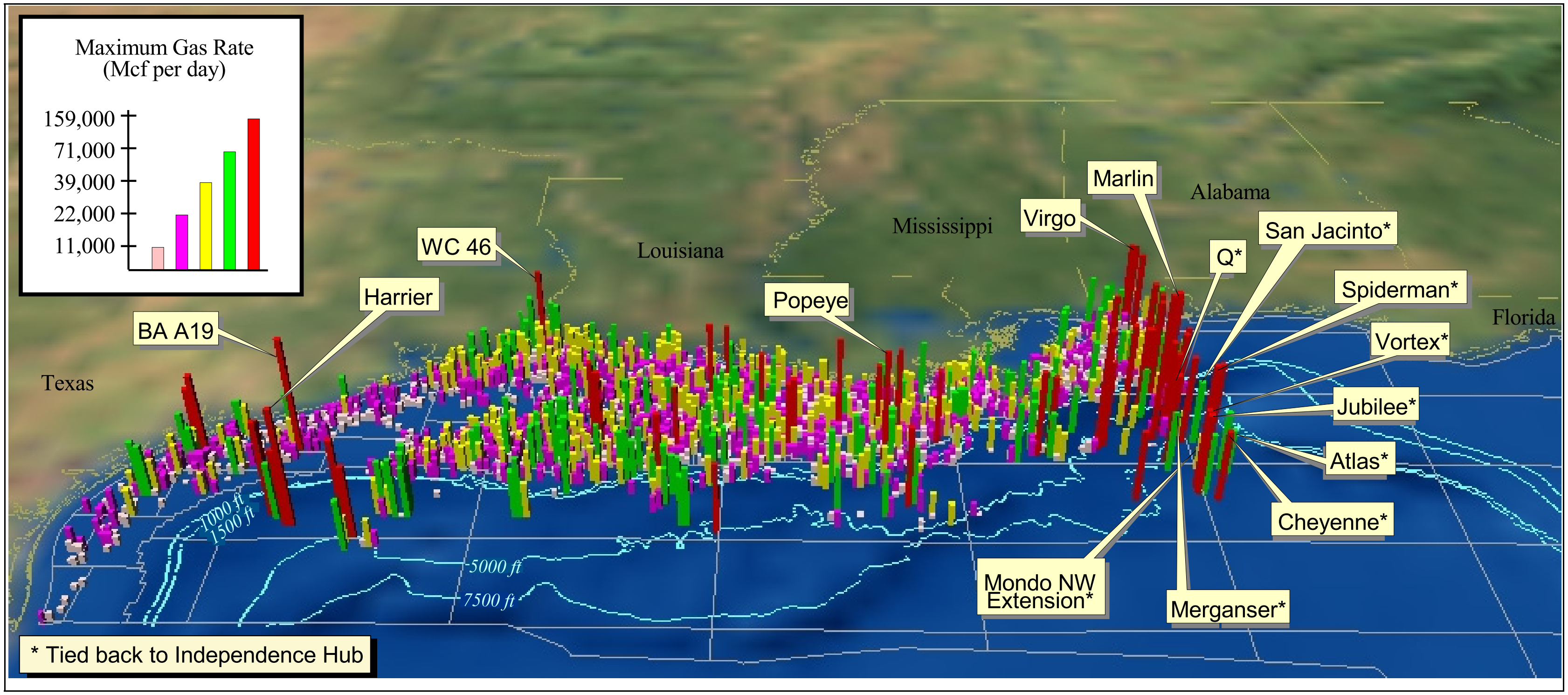


Figure 26b. Maximum historic gas well production rates.

HIGHLIGHTS AND CONCLUSIONS

HIGHLIGHTS

- At the end of 2008, 57 percent of all GOM leases were located in deep water.

- Central Lease Sale 206 attracted approximately $3.7 billion in high bids—the most since Federal offshore leasing began in 1954. The MMS received 1,057 bids from 85 companies on 615 blocks, of which 603 were ultimately awarded. Sixty-nine percent of all blocks receiving bids were in 1,000 ft (305 m) of water or greater.

- Eastern Sale 224 attracted almost $65 million in high bids. The MMS received 58 bids from six companies on 36 blocks, of which all were ultimately awarded. Sale 224 offered approximately 0.5 million acres, from what is known as the 181 Area, which has been off-limits to exploration since 1988.

- Western Lease Sale 207 attracted approximately $487 million in high bids. The MMS received 423 bids from 53 companies on 319 blocks, of which 313 were ultimately awarded. Seventy-eight percent of all blocks receiving bids were in 1,000 ft (305 m) of water or greater.

- Central Lease Sale 208 attracted approximately $703 million in high bids. The MMS received 476 bids from 70 companies on 348 blocks. Seventy-two percent of all blocks receiving bids were in 1,000 ft (305 m) of water or greater. Areas for lease in Sale 208 included approximately 4.2 million acres, from what is known as the 181 South Area, which has been off-limits to exploration since 1988.

- There are 15 newbuild MODU's being built and contracted for use in the ultra-deepwater Gulf and will be ready for operation in the next 2-3 years—they will be capable of operating in water depths up to 12,000 ft (3,658 m) and drilling up to 40,000 ft (12,192 m) in depth.

- Approximately 21 percent of the worldwide, deepwater MODU's are contracted to the GOM.

- In 2008, 108 wells were spudded in water depths greater than 1,000 ft (305 m), and nearly 80 percent were for exploration.

- Shell Oil Company set a world water depth record in drilling and completing a subsea well 9,356 ft (2,852 m) below the water surface in the Silvertip project at the Perdido Regional Host facility in Alaminos Canyon.

- There were 15 industry-announced discoveries in 2008, including one in the Lower Tertiary trend.

- Since 1975 there have been at least 285 deepwater discoveries in the GOM, of which 127 have become proved fields, accounting for 11.060 BBOE of proved reserves.

- In 2007, deep water continued to be a very important part of the total GOM production, providing approximately 70 percent of the oil and 36 percent of the gas in the region.

- There were 141 producing projects in the deepwater GOM at the end of 2008, up from 130 at the end of 2007. Seven projects came online in 2008, including record production from Thunder Horse.

- The 20 most prolific producing blocks in the GOM continue to be located in deep water.

- With the onset of production from the Thunder Horse Field in 2008, it is currently the largest daily producer in the GOM. As of March 20, 2009, production was approximately 260,000 bo/d from seven wells.

- Nine fields associated with the Independence Hub production facility came online in 2007. The hub's 1 Bcf/d capacity accounts for over 10 percent of the total gas production from the GOM.

- The first floating, production, storage, and offloading (FPSO) system in the U.S. GOM, the *BW Pioneer* vessel, will develop the Cascade and Chinook Fields in Walker Ridge, with first oil expected in 2010. Unique to the *BW Pioneer* is a detachable turret buoy, connecting the subsea wells to the FPSO.

- Petrobras' Cascade/Chinook development project will utilize four technologies considered new to the GOM, including free-standing hybrid risers, polyester mooring, electric submersible booster pumps, and shuttle tankers for oil export.

- The first ship-shape, dynamically positioned, disconnectable turret floating production unit (FPU) in the U.S. GOM, *Helix Producer I*, will develop the Phoenix Field in Green Canyon, with a planned production startup in 2010.

- The Perdido Regional Host facility will produce the Great White, Tobago, and Silvertip discoveries in Alaminos Canyon beginning in 2010. The truss spar was installed in August 2008 and set a new record as the deepest spar in over 8,000 ft (2,438 m) of water.

- Several NTL's were implemented in 2008 to inhibit the loss of or damage to offshore structures during hurricane season.

- The MMS was involved in over 35 API committees in 2008 to pave the way for acceptance of new technologies and practices as industry moves to develop prospects in a more challenging environment.

CONCLUSIONS

With complex deepwater developments, it is not uncommon for there to be considerable lag time between leasing and first production. The Thunder Horse Field illustrates the lag time that can exist between leasing and first production. It was leased in 1988, the first well was drilled in 1999, and production began in 2008. **Figure 27** demonstrates average lags associated with deepwater operations. This figure uses data from only productive deepwater leases and illustrates the lags between leasing and qualification and from qualification to first production. Operators sometimes announce discoveries to the public long before qualifying the lease as producible with MMS (and thereby granted field status). Note that, since deepwater leases are in effect for 8 or 10 years, the data are incomplete beyond 1998.

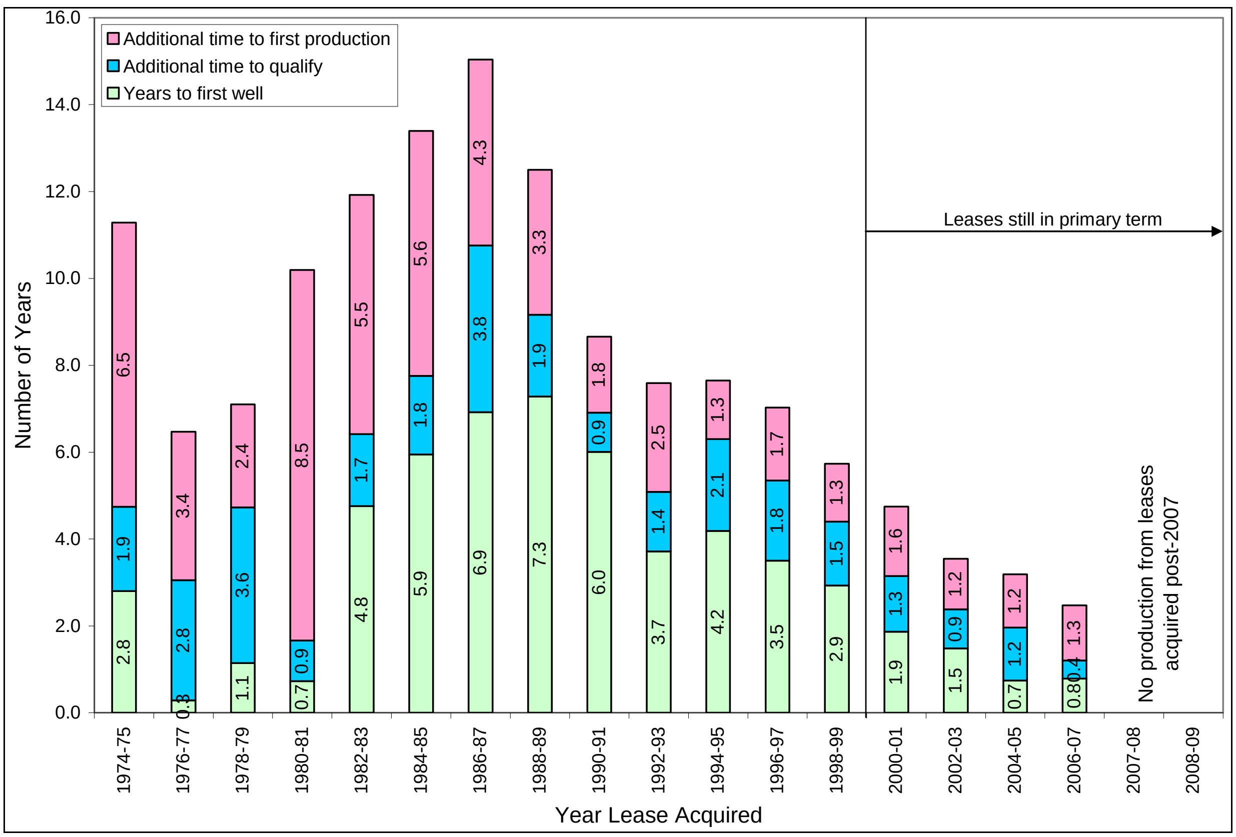


Figure 27. Average lag time from leasing to first production for producing deepwater fields.

Figure 27 indicates that, as industry gains experience in the deepwater areas of the Gulf, the time between leasing and production is reduced. Since 1988, there has been a reduction in time from lease acquisition to first well drilled. Developments near accessible infrastructure and the use of proven development technologies reduce the lag between leasing and production. Conversely, as new discoveries move into dramatically deeper water depths, and with many new discoveries being far from existing infrastructure, an increase in lag time between leasing and production should be anticipated. However, these challenges continually push industry to develop new technologies and development techniques for the GOM.

For example, the Lower Tertiary trend is in very deep water, has target depths below 25,000 ft (7,620 m), has the potential for high-pressure/high-temperature conditions, and many of the discoveries underlie a thick salt layer, all of which complicate drilling and development operations. The first fields scheduled for production from the Lower Tertiary trend in Walker Ridge are Cascade and Chinook. Because these fields are so remote from existing infrastructure, they will be developed with subsea wells tied into an FPSO, a first in U.S. GOM waters. Another example of development challenges in very deep waters is the Perdido truss spar, which will be the hub facility for the Great White, Silvertip, and Tobago projects. Because of the remote location of the facility in Alaminos Canyon Block 857, 77 mi (124 km) of oil export and 107 mi (172 km) of gas export pipeline will be installed with the facility. Additionally, Perdido represents the first application of full, host-scale subsea separation and boosting. The results of first production from Cascade/Chinook and the Perdido facility are scheduled for 2010. These results will impact all other operators in the Lower Tertiary trend, both geologically and technologically.

AMERICA'S OFFSHORE ENERGY FUTURE

The future of deepwater GOM exploration and production remains very promising. The large number of active deepwater leases, the development of important new discoveries, the growing deepwater infrastructure and new technologies, and the onset of ultra-deepwater production are all indicators of this maturing and yet still expanding frontier. All of these factors will ensure that the deepwater GOM will remain one of the world's premier oil and gas basins.

CONTRIBUTING PERSONNEL

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APPENDICES

Appendix A. Development Systems of Productive Deepwater Projects

Year of First Production	Project Name[1]	Operator	Block	Water Depth (ft)[2]	System Type
1979	Cognac	Shell	MC 194	1,023	Fixed Platform
1984	Lena	ExxonMobil	MC 280	1,000	Compliant Tower
1988	GC 29[3]	Placid	GC 29	1,540	Semisubmersible[4]/ Subsea
1988	GC 31[3]	Placid	GC 31	2,243	Subsea
1989	Bullwinkle	Shell	GC 65	1,353	Fixed Platform
1989	Jolliet	ConocoPhillips	GC 184	1,760	TLP
1991	Amberjack	British Petroleum	MC 109	1,100	Fixed Platform
1992	Alabaster	ExxonMobil	MC 485	1,438	Subsea
1993	Diamond[3]	Kerr-McGee	MC 445	2,095	Subsea
1993	Zinc	ExxonMobil	MC 354	1,478	Subsea
1994	Auger	Shell	GB 426	2,860	TLP
1994	Pompano and Pompano II	British Petroleum	VK 989	1,290	Fixed Platform/ Subsea
1994	Tahoe and SE Tahoe	Shell	VK 783	1,500	Subsea
1995	Cooper[3]	Newfield	GB 388	2,097	Semisubmersible[4]
1995	Shasta[3]	ChevronTexaco	GC 136	1,048	Subsea
1995	VK 862	Walter	VK 862	1,043	Subsea
1996	Mars	Shell	MC 807	2,933	TLP/Subsea
1996	Popeye	Shell	GC 116	2,000	Subsea
1996	Rocky[3]	Shell	GC 110	1,785	Subsea
1997	Mensa	Shell	MC 731	5,318	Subsea
1997	Neptune	Kerr-McGee	VK 826	1,930	Spar/Subsea
1997	Ram-Powell	Shell	VK 956	3,216	TLP
1997	Troika	British Petroleum	GC 200	2,721	Subsea
1998	Arnold	Marathon	EW 963	1,800	Subsea
1998	Baldpate	Amerada Hess	GB 260	1,648	Compliant Tower
1998	Morpeth	Eni	EW 921	1,700	TLP/Subsea
1998	Oyster	Marathon	EW 917	1,195	Subsea
1999	Allegheny	Eni	GC 254	3,294	TLP
1999	Angus	Shell	GC 113	2,045	Subsea
1999	Dulcimer[3]	Mariner	GB 367	1,120	Subsea
1999	EW 1006	Walter	EW 1006	1,884	Subsea
1999	Gemini	ChevronTexaco	MC 292	3,393	Subsea
1999	Genesis	ChevronTexaco	GC 205	2,590	Spar
1999	Macaroni	Shell	GB 602	3,600	Subsea
1999	Penn State	Amerada Hess	GB 216	1,450	Subsea
1999	Pluto	Mariner	MC 674	2,828	Subsea

Year of First Production	Project Name[1]	Operator	Block	Water Depth (ft) [2]	System Type
1999	Ursa	Shell	MC 809	3,800	TLP
1999	Virgo	TotalFinaElf	VK 823	1,130	Fixed Platform
2000	Allegheny South	Eni	GC 298	3,307	Subsea
2000	Black Widow	Mariner	EW 966	1,850	Subsea
2000	Conger	Amerada Hess	GB 215	1,500	Subsea
2000	Diana	ExxonMobil	EB 945	4,500	Subsea
2000	Europa	Shell	MC 935	3,870	Subsea
2000	Hoover	ExxonMobil	AC 25	4,825	Spar
2000	King	Shell	MC 764	3,250	Subsea
2000	Marlin	British Petroleum	VK 915	3,236	TLP
2000	Northwestern	Amerada Hess	GB 200	1,736	Subsea
2000	Petronius	ChevronTexaco	VK 786	1,753	Compliant Tower
2001	Brutus	Shell	GC 158	3,300	TLP
2001	Crosby	Shell	MC 899	4,400	Subsea
2001	Einset[3]	Shell	VK 872	3,500	Subsea
2001	EW 878	Walter	EW 878	1,585	Subsea
2001	Ladybug	ATP	GB 409	1,355	Subsea
2001	Marshall	ExxonMobil	EB 949	4,376	Subsea
2001	MC 68[3]	Walter	MC 68	1,360	Subsea
2001	Mica	ExxonMobil	MC 211	4,580	Subsea
2001	Nile	British Petroleum	VK 914	3,535	Subsea
2001	Oregano	Shell	GB 559	3,400	Subsea
2001	Pilsner	Unocal	EB 205	1,108	Subsea
2001	Prince	El Paso	EW 1003	1,500	TLP
2001	Serrano	Shell	GB 516	3,153	Subsea
2001	Typhoon[5]	ChevronTexaco	GC 237	2,107	TLP
2002	Aconcagua	TotalFinaElf	MC 305	7,100	Subsea
2002	Aspen	British Petroleum	GC 243	3,065	Subsea
2002	Camden Hills	Marathon	MC 348	7,216	Subsea
2002	East Boomvang[6]	Kerr-McGee	EB 688	3,795	Subsea
2002	Horn Mountain	British Petroleum	MC 127	5,400	Spar
2002	King[7]	British Petroleum	MC 84	5,418	Subsea
2002	King Kong	Mariner	GC 472	3,980	Subsea
2002	King's Peak	British Petroleum	DC 133	6,845	Subsea
2002	Lost Ark	Nobel	EB 421	2,960	Subsea
2002	Madison	ExxonMobil	AC 24	4,856	Subsea
2002	Manatee	Shell	GC 155	1,939	Subsea
2002	Nansen	Kerr-McGee	EB 602	3,685	Spar
2002	Navajo	Kerr-McGee	EB 690	4,210	Subsea
2002	North Boomvang[6]	Kerr-McGee	EB 643	3,650	Spar
2002	Princess	Shell	MC 765	3,642	Subsea

Year of First Production	Project Name[1]	Operator	Block	Water Depth (ft) [2]	System Type
2002	Sangria[3]	Hydro GOM	GC 177	1,487	Subsea
2002	Tulane	Amerada Hess	GB 158	1,054	Subsea
2002	Yosemite	Mariner	GC 516	4,150	Subsea
2003	Boris[5]	BHP Billiton	GC 282	2,378	Subsea
2003	Dawson[8]	Kerr-McGee	GB 669	3,152	Subsea
2003	Durango[8]	Kerr-McGee	GB 667	3,105	Subsea
2003	East Anstey/Na Kika	Shell	MC 607	6,590	Semisubmersible/ Subsea[9]
2003	Falcon	Marubeni	EB 579	3,638	Subsea
2003	Fourier/Na Kika	Shell	MC 522	6,940	Semisubmersible/ Subsea[9]
2003	Gunnison	Kerr-McGee	GB 668	3,100	Spar
2003	Habanero	Shell	GB 341	2,015	Subsea
2003	Herschel/Na Kika	Shell	MC 520	6,739	Semisubmersible/ Subsea[9]
2003	Matterhorn	TotalFinaElf	MC 243	2,850	TLP
2003	Medusa	Murphy	MC 582	2,223	Spar
2003	North Medusa	Murphy	MC 538	2,223	Subsea
2003	Pardner	Anadarko	MC 401	1,139	Subsea
2003	Tomahawk	Marubeni	EB 623	3,412	Subsea
2003	West Boomvang[6]	Kerr-McGee	EB 642	3,678	Subsea
2003	Zia	Devon	MC 496	1,804	Subsea
2004	Ariel/Na Kika	British Petroleum	MC 429	6,240	Semisubmersible/ Subsea[9]
2004	Coulomb/Na Kika	Shell	MC 657	7,591	Semisubmersible/ Subsea[9]
2004	Devil's Tower	Eni	MC 773	5,610	Spar
2004	Front Runner	Murphy	GC 338	3,330	Spar
2004	GB 208	McMoran	GB 208	1,275	Subsea
2004	Glider	Shell	GC 248	3,440	Subsea
2004	Hack Wilson	Kerr-McGee	EB 599	3,650	Subsea
2004	Harrier[3]	Pioneer	EB 759	4,114	Subsea
2004	Holstein	British Petroleum	GC 645	4,340	Spar
2004	Kepler/Na Kika	British Petroleum	MC 383	5,759	Semisubmersible/ Subsea[9]
2004	Llano	Shell	GB 386	2,340	Subsea
2004	Magnolia	ConocoPhilips	GB 783	4,674	TLP
2004	Marco Polo	Anadarko	GC 608	4,300	TLP
2004	MC 837	Walter	MC 837	1,524	Subsea
2004	Ochre	Mariner	MC 66	1,144	Subsea
2004	Raptor	Pioneer	EB 668	3,710	Subsea
2004	Red Hawk	Kerr-McGee	GB 877	5,300	Spar
2004	South Diana	ExxonMobil	AC 65	4,852	Subsea

Year of First Production	Project Name[1]	Operator	Block	Water Depth (ft) [2]	System Type
2005	Baccarat	W and T Offshore	GC 178	1,404	Subsea
2005	Citrine	LLOG	GC 157	2,614	Subsea
2005	GC 137	Nexen	GC 137	1,168	Subsea
2005	K2	Anadarko	GC 562	4,006	Subsea
2005	Killer Bee	Walter	MC 582	2,223	Subsea
2005	Mad Dog	British Petroleum	GC 782	4,420	Spar
2005	Swordfish	Noble	VK 962	4,677	Subsea
2005	Triton and Goldfinger	Eni	MC 728	5,610	Subsea
2006	Constitution	Kerr-McGee	GC 680	4,970	Spar
2006	Dawson Deep	Kerr-McGee	GB 625	2,965	Subsea
2006	Gomez	ATP	MC 711	2,975	Semisubmersible
2006	K2 North	Anadarko	GC 518	4,049	Subsea
2006	Lorien	Noble	GC 199	2,315	Subsea
2006	Rigel	Eni	MC 252	5,225	Subsea
2006	Seventeen Hands	Eni	MC 299	5,881	Subsea
2006	SW Horseshoe	Walter	EB 430	2,285	Subsea
2006	Ticonderoga	Kerr-McGee	GC 768	5,272	Subsea
2007	Anduin	ATP	MC 755	2,904	Subsea
2007	Atlantis	British Petroleum	GC 787	7,050	Semisubmersible
2007	Atlas-AtlasNW/Ind. Hub	Anadarko	LL 50	8,934	FPS/Subsea[10]
2007	Cheyenne/Ind. Hub	Anadarko	LL 399	8,951	FPS/Subsea[10]
2007	Cottonwood	Petrobras	GB 244	2,130	Subsea
2007	Deimos	Shell	MC 806	3,106	Subsea
2007	Jubilee/Ind. Hub	Anadarko	AT 349	8,825	FPS/Subsea[10]
2007	Merganse /Ind. Hub	Anadarko	AT 37	8,015	FPS/Subsea[10]
2007	Mondo NW/Ind. Hub	Anadarko	LL 1	8,340	FPS/Subsea[10]
2007	Q/Ind. Hub	Hydro GOM	MC 961	7,925	FPS/Subsea[10]
2007	San Jacinto/Ind. Hub	Eni	DC 618	7,850	FPS/Subsea[10]
2007	Shenzi[11]	BHP Billiton	GC 652	4,300	TLP/Subsea
2007	Spiderman/Ind. Hub	Anadarko	DC 621	8,087	FPS/Subsea[10]
2007	Tiger	DeepGulf Energy	GC 195	1,900	Subsea
2007	Vortex/Ind. Hub	Anadarko	AT 261	8,344	FPS/Subsea[10]
2007	Wrigley	Newfield	MC 506	3,911	Subsea
2008	Bass Lite	Mariner	AT 426	6,634	Subsea
2008	Blind Faith	ChevronTexaco	MC 696	6,989	Semisubmersible
2008	MC 161	Walter	MC 161	2,924	Subsea
2008	Neptune	BHP Billiton	AT 575	4,232	TLP
2008	Raton	Nobel	MC 248	3,290	Subsea
2008	Thunder Horse	British Petroleum	MC 778	6,037	Semisubmersible
2008	Valley Forge	LLOG	MC 707	1,538	Subsea
2009	Clipper	ATP	GC 299	3,452	

Year of First Production	Project Name[1]	Operator	Block	Water Depth (ft)[2]	System Type
2009	Dorado	British Petroleum	VK 915	3,236	Subsea
2009	Geauxpher	Mariner	GB 462	2,823	
2009	GB 302	Walter	GB 302	2,410	Subsea
2009	Isabela	British Petroleum	MC 562	6,500	Subsea
2009	Longhorn	Eni	MC 502	2,442	Subsea
2009	MC 72	LLOG	MC 72	2,013	
2009	MC 583	Walter	MC 583	2,487	
2009	Mirage and Morgus	ATP	MC 941	4,000	Mini TLP
2009	Pegasus	Eni	GC 385	3,498	Subsea
2009	Tahiti	ChevronTexaco	GC 640	4,000	Spar
2009	Thunder Hawk	Murphy	MC 734	6,050	Semisubmersible
2009	Thunder Horse North	British Petroleum	MC 776	5,660	Subsea
2009	Unreleasable[12]				
2009	Unreleasable[12]				
2009	Unreleasable[12]				
2010	Caesar and Tonga	Anadarko	GC 683	4,672	Subsea
2010	Cascade	Petrobras	WR 206	8,143	FPSO/Subsea[13]
2010	Chinook	Petrobras	WR 469	8,831	FPSO/Subsea[13]
2010	Droshky	Marathon	GC 244	2,900	
2010	Great White	Shell	AC 857	8,000	Spar
2010	MC 241	Walter	MC 241	2,415	
2010	Phoenix[5]	Helix	GC 237	2,679	FPU
2010	Silvertip	Shell	AC 815	9,226	Subsea
2010	Telemark	ATP	AT 63	4,385	Mini TLP
2010	Tobago	Shell	AC 859	9,627	Subsea
2010	Unreleasable[12]				
2010	Unreleasable[12]				
2011	Ozona	Marathon	GB 515	3,000	
2012	Unreleasable[12]				
2012	Unreleasable[12]				
2013	Unreleasable[12]				
2013	Unreleasable[12]				
2013	Unreleasable[12]				
2013	Unreleasable[12]				
2013	Unreleasable[12]				
2013	Unreleasable[12]				
2013	Unreleasable[12]				
2013	Unreleasable[12]				
2013	Puma	British Petroleum	GC 823	4,129	
2014	Unreleasable[12]				
2016	Unreleasable[12]				

[1] Editions of this report prior to 2004 listed deepwater fields rather than projects. A block may be listed under more than one project name because of lease relinquishment, expiration, or termination and subsequent re-leasing. Some announced discoveries never reached the project stage and are listed under their prospect names.

[2] Water depths are approximate and may vary depending on the location of the production facility or the location of a well (average of wells or deepest well site).

[3] Indicates projects that are no longer on production.

[4] The semisubmersibles associated with the GC 29 and Cooper projects have been removed.

[5] The TLP associated with the Typhoon and Boris projects was destroyed by Hurricane Rita in 2005. Helix is scheduled to redevelop the projects with an FPU by early 2010. The new project name is Phoenix.

[6] 2004 Report referred to entire area as Boomvang.

[7] Includes King South.

[8] Included in 2004 Report with Gunnison.

[9] Na Kika semisubmersible is located in Mississippi Canyon Block 474 in 6,378 ft (1,944 m) of water.

[10] Independence Hub FPS is located in Mississippi Canyon Block 920 in 7,920 ft (2,414 m) of water.

[11] The Shenzi project includes the Genghis Khan development. Production commenced from Genghis Khan in October 2007 and will be transported to the Marco Polo TLP in Green Canyon Block 608 in 4,300 ft (1,311 m) of water. The Shenzi portion of the project will feature a TLP in Green Canyon Block 653 in 4,812 ft (1,467 m) of water and is scheduled to commence production in mid-2009.

[12] Unreleasable—operator has commitment to produce and/or is planning to develop project but has not publicly released project information.

[13] The Cascade and Chinook Fields will be developed by an FPSO operated by Petrobras. The FPSO will be located in Walker Ridge Block 249 in approximately 8,200 ft (2,499 m) of water.

APPENDIX B. AVERAGE ANNUAL GOM OIL AND GAS PRODUCTION

Year	Shallow-Water Oil (MMbbl)	Deepwater Oil (MMbbl)	Total GOM Oil (MMbbl)	Shallow-Water Gas (Bcf)	Deepwater Gas (Bcf)	Total GOM Gas (Bcf)
1947	0	0	0	0	0	0
1948	0	0	0	0	0	0
1949	0	0	0	0	0	0
1950	0	0	0	0	0	0
1951	0	0	0	2	0	2
1952	1	0	1	19	0	19
1953	1	0	1	25	0	25
1954	2	0	2	60	0	60
1955	4	0	4	87	0	87
1956	7	0	7	91	0	91
1957	12	0	12	93	0	93
1958	20	0	20	144	0	144
1959	30	0	30	224	0	224
1960	41	0	41	281	0	281
1961	56	0	56	335	0	335
1962	77	0	77	451	0	451
1963	96	0	96	561	0	561
1964	111	0	111	645	0	645
1965	136	0	136	743	0	743
1966	175	0	175	992	0	992
1967	210	0	210	1,285	0	1,285
1968	254	0	254	1,600	0	1,600
1969	292	0	292	1,950	0	1,950
1970	329	0	329	2,402	0	2,402
1971	376	0	376	2,729	0	2,729
1972	373	0	373	3,004	0	3,004
1973	366	0	366	3,312	0	3,312
1974	338	0	338	3,418	0	3,418
1975	310	0	310	3,427	0	3,427
1976	301	0	301	3,556	0	3,556
1977	284	0	284	3,767	0	3,767
1978	276	0	276	4,244	0	4,244
1979	263	1	263	4,668	0	4,669
1980	260	5	265	4,762	4	4,766
1981	260	4	263	4,886	3	4,888
1982	273	13	286	4,650	16	4,666
1983	294	26	320	4,034	41	4,075
1984	330	25	355	4,525	39	4,564
1985	329	21	350	4,024	34	4,058
1986	336	19	356	4,006	37	4,043

Year	Shallow-Water Oil (MMbbl)	Deepwater Oil (MMbbl)	Total GOM Oil (MMbbl)	Shallow-Water Gas (Bcf)	Deepwater Gas (Bcf)	Total GOM Gas (Bcf)
1987	310	17	328	4,481	44	4,525
1988	288	13	301	4,539	38	4,577
1989	271	10	281	4,604	32	4,636
1990	262	12	275	4,876	31	4,906
1991	272	23	295	4,637	58	4,695
1992	268	37	305	4,555	87	4,642
1993	272	37	309	4,536	120	4,656
1994	272	42	314	4,664	159	4,824
1995	290	55	345	4,598	181	4,779
1996	297	72	369	4,799	278	5,077
1997	303	108	412	4,764	382	5,146
1998	285	159	444	4,481	560	5,042
1999	270	225	495	4,211	846	5,057
2000	252	271	523	3,959	999	4,958
2001	243	315	559	3,881	1,178	5,059
2002	219	349	568	3,238	1,285	4,523
2003	211	350	561	3,000	1,425	4,426
2004	187	348	535	2,606	1,396	4,003
2005	141	326	467	1,963	1,189	3,152
2006	131	339	469	1,823	1,089	2,912
2007	140	328	467	1,776	1,015	2,791

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.