

Estimated Oil and Gas Reserves Pacific Outer Continental Shelf

(as of December 31, 1996)



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by
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COVER PHOTO: Chevron's Platform Gail, which was installed in 1987 in 739 feet of water. Wells drilled from this 36-slot platform have been producing oil and gas from Sockeye Field in the eastern Santa Barbara Channel since September 1988. *Photograph by Ralph Vasquez, Minerals Management Service, Camarillo, CA.*

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Abbreviations

ACT	Actively Drilling
APD	Application for Permit to Drill
API	American Petroleum Institute
°API.....	Oil Gravity
bbl	Barrel of Oil (42 gallons)
Bcf	Billion Cubic Feet of Gas
BOE	Barrels of Oil Equivalent
bpd	Barrels per Day
cf.....	Cubic Feet
CFR	Code of Federal Regulations
COM	Completion
CRPNTR	Carpinteria Offshore Field
DPP	Development and Production Plan
DSCDRS	Dos Cuadras Field
DSI	Drilling Shut-In
°F	Degrees Fahrenheit
GIW	Gas Injection Well
GLO	Gas Lift Oil Well
GSI	Gas Well Shut-in
HUENEM	Hueneme Field
Mbbl	Thousand Barrels of Oil
Mcf	Thousand Cubic Feet of Gas
Mcfpd	Thousand Cubic Feet of Gas per Day
MMbbl.....	Million Barrels of Oil
MMcf	Million Cubic Feet of Gas
MMS	Minerals Management Service
OCS.....	Outer Continental Shelf
OFR.....	Open File Report
OSI	Oil Well Shut-in
PA	Plugged and Abandoned
PESCDO	Pescado Field
PGW	Producing Gas Well
PITSPT	Pitas Point Field
POW	Producing Oil Well
psia	Pounds per Square Inch Absolute
PTARGL	Point Arguello Field
PTPDNS	Point Pedernales Field
SNTCLR	Santa Clara Field
SOCKEY	Sockeye Field
SPE	Society of Petroleum Engineers
ST	Side Track
TA	Temporarily Abandoned
USGS	U.S. Geological Survey
WDW	Water Disposal Well
WIW	Water Injection Well
WSW	Water Source Well

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Abstract

Proved reserves of oil¹ and gas² in the Pacific Outer Continental Shelf (OCS), offshore California, are estimated to be 598 million barrels and 1,604 billion cubic feet, respectively, as of December 31, 1996. These reserves are attributed to 12 fields. Original recoverable oil and gas reserves for these fields are estimated to be 1,412 million barrels and 2,360 billion cubic feet, respectively. Unproved reserves are estimated to be 643 million barrels of oil and 776 billion cubic feet of gas, in 26 fields.

Reserve estimates for 31 of the 38 Pacific OCS fields were calculated using individual reservoir volumetric studies. Both decline-curve and volumetric analyses were used for the remaining 7 fields. Approximately two-thirds of the original recoverable oil and gas reserves and three-fourths of the remaining reserves are attributed to reservoirs in the Monterey Formation. Over one-half of the remaining oil reserves are contained within fields that have not yet been developed.

Eleven of the 38 fields were producing at yearend. Oil production during 1996 exceeded 64 million barrels. Net gas production approached 51 billion cubic feet. To date, approximately 814 million barrels of oil and 756 billion cubic feet of gas have been produced from 11 fields.

¹ *Oil*, as used in this report, includes crude oil and condensate.

² *Gas*, as used in this report, includes associated and nonassociated dry gas.

Introduction

This report, which in part supersedes OCS Report MMS 96-0060 (Sorensen and others, 1996), presents estimates of original recoverable oil and gas reserves, cumulative production through 1996, and estimates of remaining reserves as of December 31, 1996, for the Pacific Outer Continental Shelf (OCS), offshore California. These estimates were completed in September 1997. Detailed reserves estimates are included in the annual update of this report as part of a Minerals Management Service (MMS) continuing program to provide a current inventory of oil and gas reserves for the Pacific OCS.

Beginning in the 1995 report (MMS 96-0060) the Pacific OCS Region has modified the method of gas reserves computation. Volumes of gas that have been reinjected into the reservoir are now being subtracted from yearly production. This change affects gas reserves in the Beta, Carpinteria Offshore, Hondo, Point Pedernales, and Pescado fields. All gas volumes in this report are net figures as described above, unless specified otherwise.

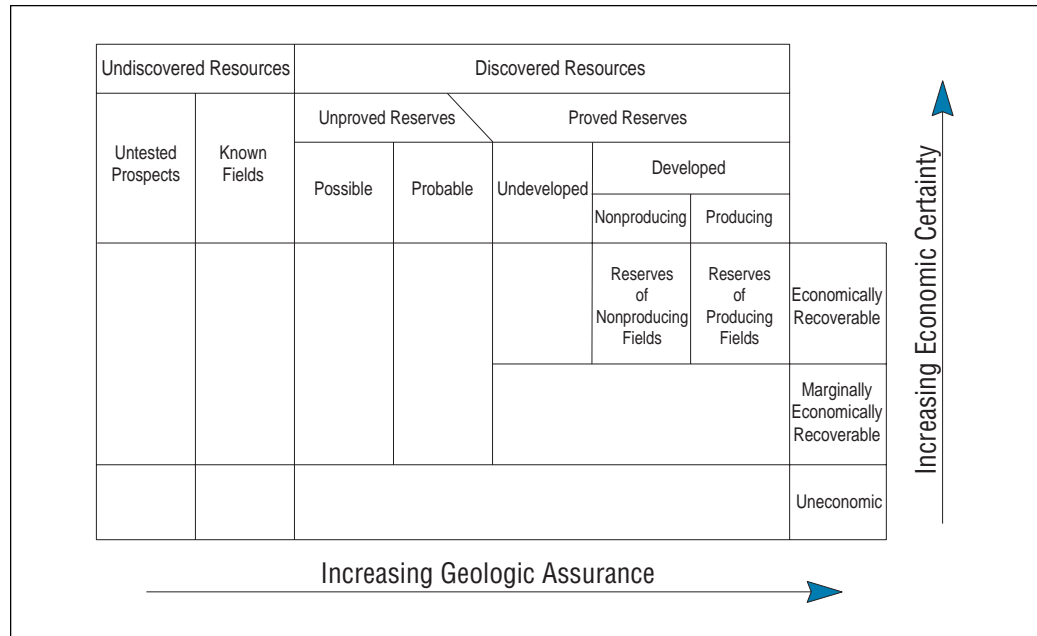
The estimates presented here were prepared by petroleum engineers, geologists, geophysicists, and other personnel from the MMS Pacific OCS Regional Office, Camarillo, California. Previous reserves reports were used as a basis for parts of this update. Contributions by the members of the Production and Development Section were key in making this report comprehensive.

Definition of Resource and Reserve Terminology

The MMS has standardized its definitions of resources (*Estimates of Undiscovered Conventional Oil and Gas Resources in the United States—A Part of the Nation's Energy Endowment*, U.S. Geological Survey (USGS) and MMS, 1989). The Society of Petroleum Engineers (SPE) has also adopted a standardized set of reserve categories and definitions (SPE 1987, p. 577-578). The definitions used within this report conform with both these sources. Figure 1 shows how resource and reserve definitions are related.

<i>Undiscovered Resources</i>	Resources estimated from broad geologic knowledge or theory and existing outside of known fields or known accumulations are undiscovered resources. Undiscovered resources can exist in untested prospects on unleased acreage, or on undrilled leased acreage, or in known fields. In known fields, undiscovered resources occur in undiscovered pools that are controlled by distinctly separate structural features or stratigraphic conditions (USGS and MMS, 1989).
<i>Discovered Resources</i>	Once leased acreage is drilled and is determined to contain oil or gas under Code of Federal Regulations (CFR) Title 30, Part 250, Subpart A, Section 11, Determination of Well Producibility (hereinafter referred to as 30 CFR 250.11),

Figure 1.
MMS Petroleum reserves classification (modified from USGS and MMS, 1989; and SPE, 1987).



the lease is considered to have discovered resources. Discovered resources are the equivalent of identified resources as reported by Dolton and others (1981). Identified resources are resources whose location and quantity are known or are estimated from specific geologic or engineering evidence and include economic, marginally economic, and subeconomic components. Discovered resources can be further characterized as unproved or proved reserves, depending upon evidence of economic and geologic viability. Changing economic conditions and new geologic data and interpretations can result in reclassification of resources. Figure 2 shows the number of Pacific OCS wells determined to be producible in accordance with 30 CFR 250.11.

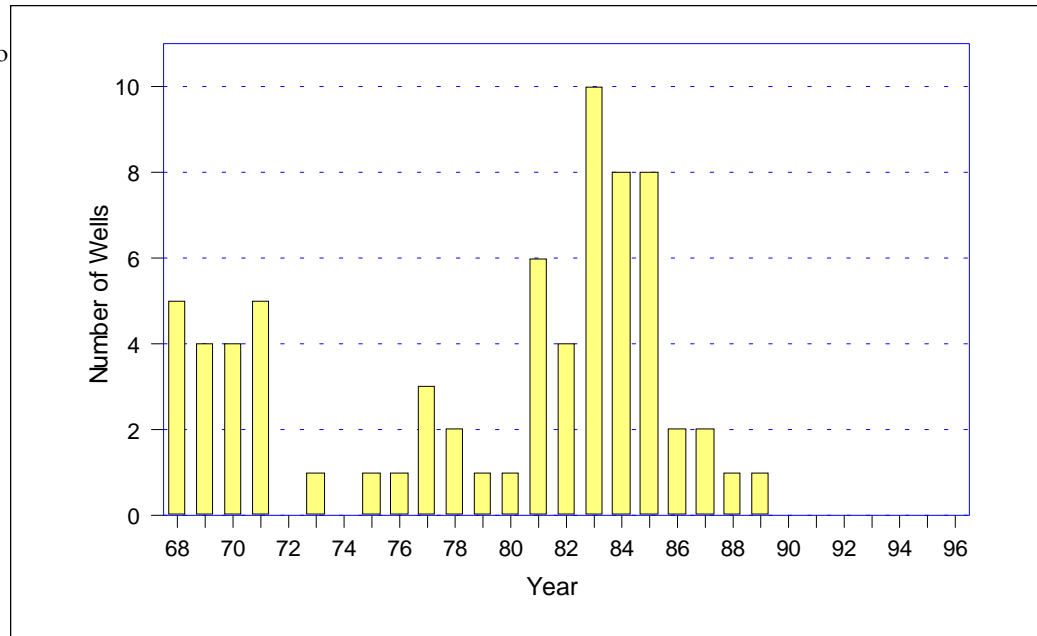
Unproved Reserves

After a lease qualifies under 30 CFR 250.11, the MMS Field Naming Committee reviews the new producible lease to assign it to an existing field or, if the lease is not associated with an established geologic structure, to a new field. Regardless of where the lease is assigned, the reserves associated with the lease are initially considered to be unproved reserves. Unproved reserves are based on geologic or engineering information similar to that used in estimates of proved reserves, but technical, contractual, economic, or regulatory uncertainties preclude such reserves being classified as proved.

Unproved reserves may be subdivided into possible and probable reserves, which are similarly based on the level of uncertainty.

“Unproved possible reserves are less certain than unproved probable reserves and can be estimated with a low degree of certainty, which is insufficient to indicate whether they are more likely to be recovered than not. Reservoir characteristics are such that a reasonable doubt exists that the project will be

Figure 2.
Wells determined to be producible in accordance with 30 CFR 250.11, Pacific OCS



commercial” (SPE, 1987). After a lease qualifies under 30 CFR 250.11, the reserves associated with the lease are initially classified as unproved possible.

“*Unproved probable reserves* are less certain than proved reserves and can be estimated with a degree of certainty sufficient to indicate they are more likely to be recovered than not” (SPE, 1987). Reserves in fields for which a schedule leading to a Development and Production Plan (DPP) has been submitted to the MMS have been classified as unproved probable.

Proved Reserves

“Proved reserves can be estimated with reasonable certainty to be recoverable under current economic conditions, such as prices and costs prevailing at the time of the estimate. Proved reserves must either have facilities that are operational at the time of the estimate to process and transport those reserves to market or a commitment or reasonable expectation to install such facilities in the future” (SPE, 1987). Proved reserves can be subdivided into undeveloped and developed.

Reserves are classified as *proved undeveloped reserves* when a relatively large expenditure is required to install production/transportation facilities, a commitment by the operator is made, and a timeframe to begin production is established. Proved undeveloped reserves are reserves expected to be recovered from (1) yet undrilled wells, (2) deepening existing wells, or (3) existing wells for which relatively large expenditures are required for recompletion.

“Reserves that are expected to be recovered from existing wells (including reserves behind pipe) are classified as *proved developed reserves*. Reserves are considered developed only after necessary production and transportation

equipment have been installed or when the installation costs are relatively minor. Proved developed reserves are subcategorized as producing or non-producing” (SPE, 1987). This distinction is made at the reservoir level and not at the field level.

Once the first reservoir in a field begins production, the reservoir is considered to contain *proved developed producing reserves*, and the field is considered on production. If a reservoir had sustained production during the last year, it is considered to contain proved developed producing reserves.

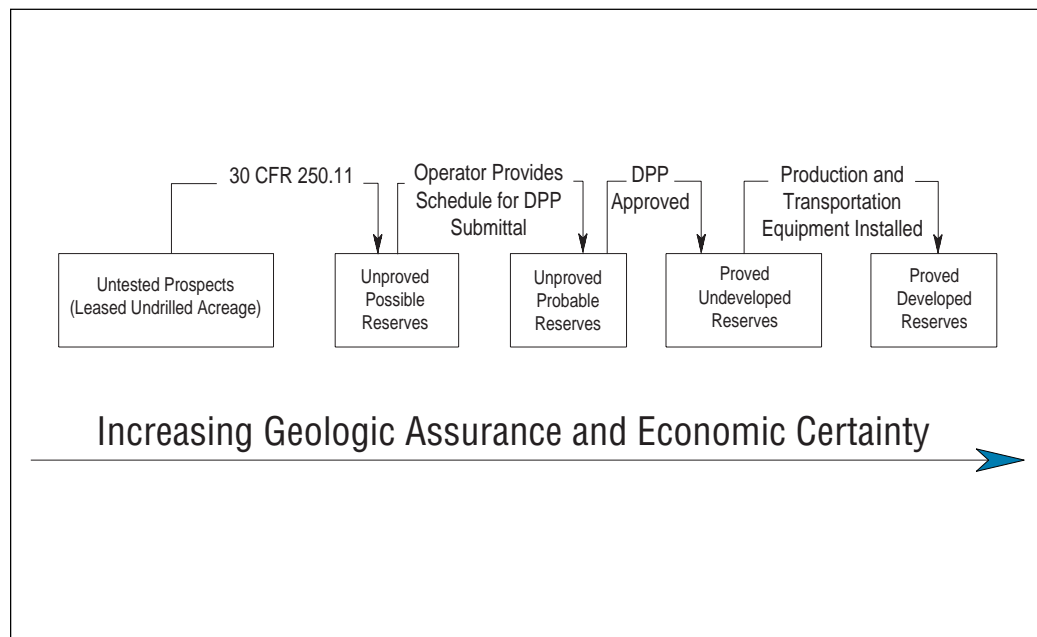
Any developed reservoir in a developed field that has not produced or has not had sustained production during the past year is considered to contain *proved developed nonproducing reserves*. This category includes reserves contained in nonproducing reservoirs, reserves contained behind-pipe, and reservoirs awaiting well workovers or transportation facilities. The reserves classification procedure is shown in figure 3.

Total reserves are the sum of proved and unproved reserves.

The amount of oil and gas expected to be recovered from the original oil in place or the amount equal to the sum of cumulative production and remaining reserves is considered to be the *original recoverable reserves*.

The term *production data* means the measured volumes of gross hydrocarbons reported to the MMS by Federal lessees and operators. Oil and gas volume

Figure 3.
MMS Pacific OCS
reserves
classification
procedure.



measurements and reserves are corrected to reference standard conditions of 60 °F and 14.73 psia. Continuously measured volumes from production platforms or leases are allocated to individual wells and reservoirs on the basis of periodic well tests. These procedures introduce approximations in both production and reserves data by reservoirs and by fields.

Methods Used for Estimating Reserves

<i>Volumetric Calculation</i>	For the volumetric calculation of reserves, the amounts of original oil and gas in place are estimated from the bulk volume of the reservoir as mapped using data from boreholes and seismic profiles. Maps of net oil and gas sand thicknesses are generated with the aid of a computer mapping system, and the results are converted to bulk reservoir volume using the appropriate equations. Rock porosities and the amounts of water, oil, and gas in the pore space are derived from well log interpretations and core analyses. The estimated original amounts of oil and gas in place are converted to standard conditions through analyses of pressure, volume, and temperature relationships and by the use of standard correlations. The amounts of the original oil and gas in place that can be recovered are estimated from information about the reservoir drive mechanism, well spacing, analog field recovery factors, and American Petroleum Institute (API) recovery factor equations (Arps and others, 1967, p. 19-20).
<i>Decline Curve Analysis</i>	In the decline-curve analysis method, future production is estimated by extrapolating plots of production rates and fluid percentages versus time. The ultimate production is determined by adding cumulative past production to predicted future production.

Fields Reported

As of December 31, 1996, there are 38 fields in the Pacific OCS that are recognized as containing reserves under the established criteria. Two of these fields are gas fields, 27 are oil fields, and 9 are combination oil and gas fields (fig. 4).

Twelve fields were determined to have proved reserves of oil/gas. These 12 fields are Point Pedernales, Point Arguello, Pescado, Sacate, Hondo, Dos Cuadras, Pitas Point, Carpinteria Offshore, Santa Clara, Sockeye, Hueneme, and Beta (fig. 4, fields 7, 11, 20, 21, 23, 29, 30, 31, 33, 34, 36, and 38). All of these fields, with the exception of Sacate, were producing at yearend. The remaining 26 fields were determined to have unproved hydrocarbon reserves.

Reserve estimates for seven of the producing fields were obtained from volumetric calculations and decline-curve analyses: Hondo, Dos Cuadras, Pitas

Point, Carpinteria Offshore, Santa Clara, Hueneme, and Beta (fig. 4, fields 23, 29, 30, 31, 33, 36, and 38). Individual reservoirs in each field were grouped for volumetric calculations, while decline-curve analyses were made on lease-by-lease and platform bases. The 31 remaining fields (4 producing and 27 nonproducing) were studied on a reservoir-by-reservoir basis, and the reserve estimates were determined solely by the volumetric calculation method.

Estimated Oil and Gas Reserves

As of December 31, 1996, total original recoverable oil and gas reserves in the Pacific OCS are estimated to be 2,055 million barrels (MMbbl) and 3,136 billion cubic feet (Bcf), respectively. Total remaining reserves are estimated to be 1,241 MMbbl of oil and 2,380 Bcf of gas.

The current aggregated estimates of Pacific OCS oil and gas reserves are shown in table 1, by SPE reserves category, for both original recoverable and remaining reserves. Nonaggregated estimates of the original recoverable and remaining reserves for each of the 11 producing oil and gas fields are presented in figures 5 and 6 and table 2.

These estimates have been updated annually as additional information has become available. Past updates have caused both increases and decreases in estimates of original recoverable and remaining oil and gas reserves. Previous reserves estimates for the Pacific OCS are presented in appendix A.

Table 1.
Estimated reserves of oil and gas by SPE category, Pacific OCS, December 31, 1996.

Reserves Category	Number of Fields	Original Recoverable Reserves		Cumulative Production		Annual Production		Remaining Reserves	
		Oil (MMbbl)	Gas (Bcf)	Oil (MMbbl)	Gas (Bcf)	Oil (MMbbl)	Gas (Bcf)	Oil (MMbbl)	Gas (Bcf)
Proved Developed	11	1,341	2,153	814	756	64	51	527	1,397
Proved Undeveloped	1	71	208	0	0	0	0	71	208
Unproved Possible - Active Leases	14	505	425	0	0	0	0	505	425
Unproved Possible - Expired Leases	12	138	351	0	0	0	0	138	351
Total	38	2,055	3,136	814	756	64	51	1,241	2,380

Figure 4.
 Recognized discoveries of federally controlled oil and gas fields in the Pacific OCS. (Dashed lines indicate 3-geographic mile boundary between State and Federal waters.)

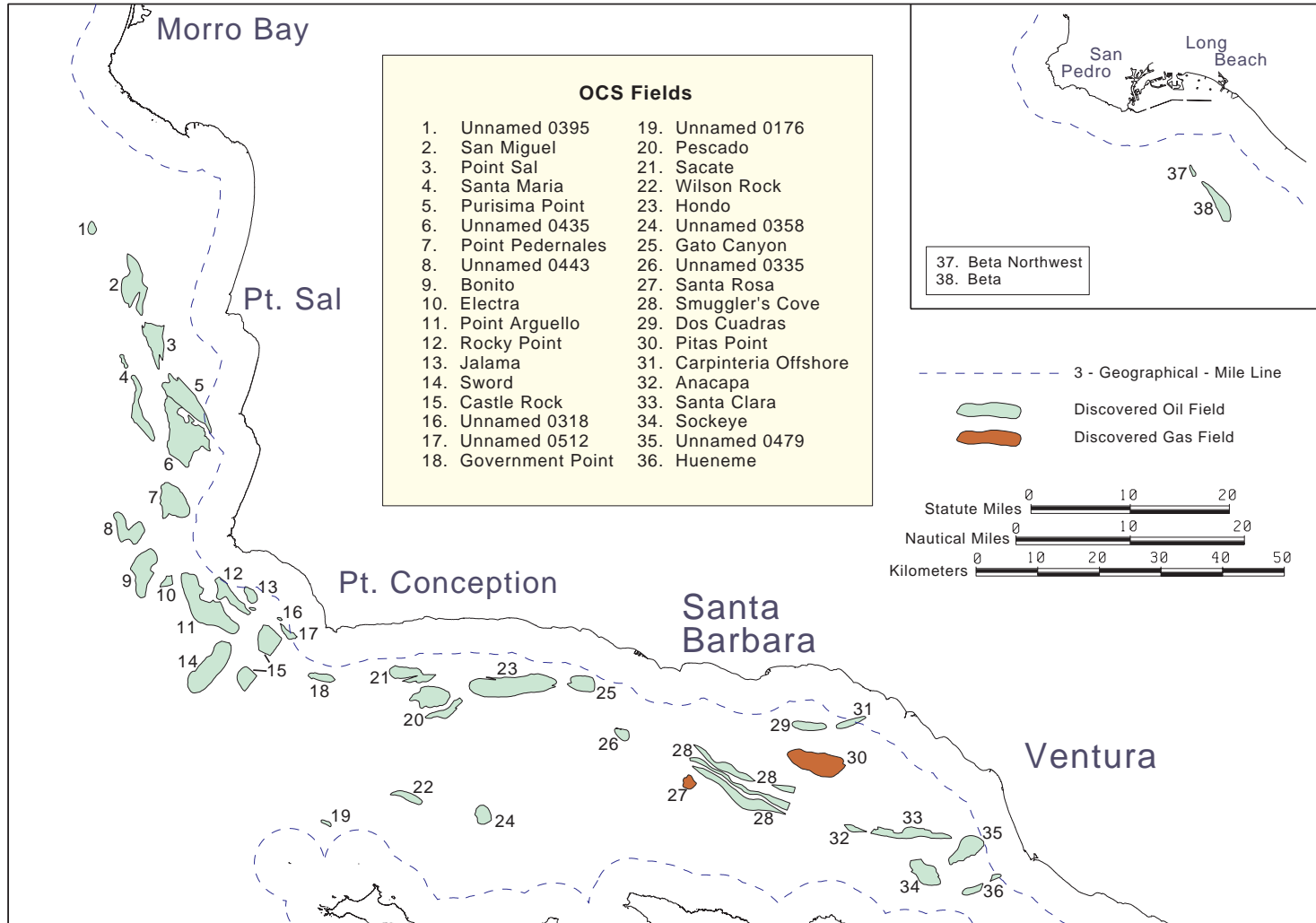


Table 2.
Production and estimated reserves of oil and gas for producing fields, Pacific OCS, December 31, 1996.

Field	Original Recoverable Reserves		Cumulative Production		1996 Annual Production		Remaining Reserves	
	Oil (MMbbl)	Gas (Bcf)	Oil (MMbbl)	Gas (Bcf)	Oil (MMbbl)	Gas (Bcf)	Oil (MMbbl)	Gas (Bcf)
Beta	116.50	32.25	73.02	23.49	3.16	0.87	43.48	8.76
Carpinteria	65.20	55.00	61.47	47.04	0.80	0.48	3.73	7.96
Dos Cuadras	256.80	137.60	239.08	122.62	2.76	2.85	17.72	14.98
Hondo	278.90	834.02	170.96	175.01	16.71	21.24	107.94	659.01
Hueneme	10.57	4.38	9.48	3.64	0.31	0.43	1.09	0.74
Pescado	110.79	222.32	42.19	1.65	18.00	0.39	68.6	220.67
Pitas Point	0.27	239.22	0.19	196.15	0.01	5.24	0.08	43.06
Point Arguello	283.88	336.84	112.6	56.81	14.62	10.09	171.28	280.03
Point Pedernales	77.30	17.00	51.66	12.83	4.17	1.87	25.64	4.17
Santa Clara	70.13	109.37	33.25	59.64	1.46	1.27	36.88	49.73
Sockeye	70.73	164.78	20.35	57.18	2.31	5.92	50.38	107.60
Total	1,341.07	2,152.77	814.26	756.08	64.3	50.64	526.81	1,396.69

Table 3.
Changes in reported reserves and production, Pacific OCS, December 31, 1996.

Production and Reserves	Oil (MMbbl)	Gas (Bcf)
Original Recoverable Reserves:		
Estimated as of 12/31/96 (This Report)	2,055	3,136
Estimated as of 12/31/95 (MMS 96-0060)	2,055	3,136
Change	0	0
Cumulative Production:		
Through 1996	814	756
Through 1995	750	703
Proved Reserves:		
Estimated as of 12/31/96 (This Report)	598	1,604
Estimated as of 12/31/95 (MMS 96-0060)	662	1,657
Change	-64	-53
Total Reserves:		
Estimated as of 12/31/96 (This Report)	1,241	2,380
Estimated as of 12/31/95 (MMS 96-0060)	1,305	2,434
Change	-64	-54

Figure 5.
Production and estimated reserves of oil for producing fields, Pacific OCS.

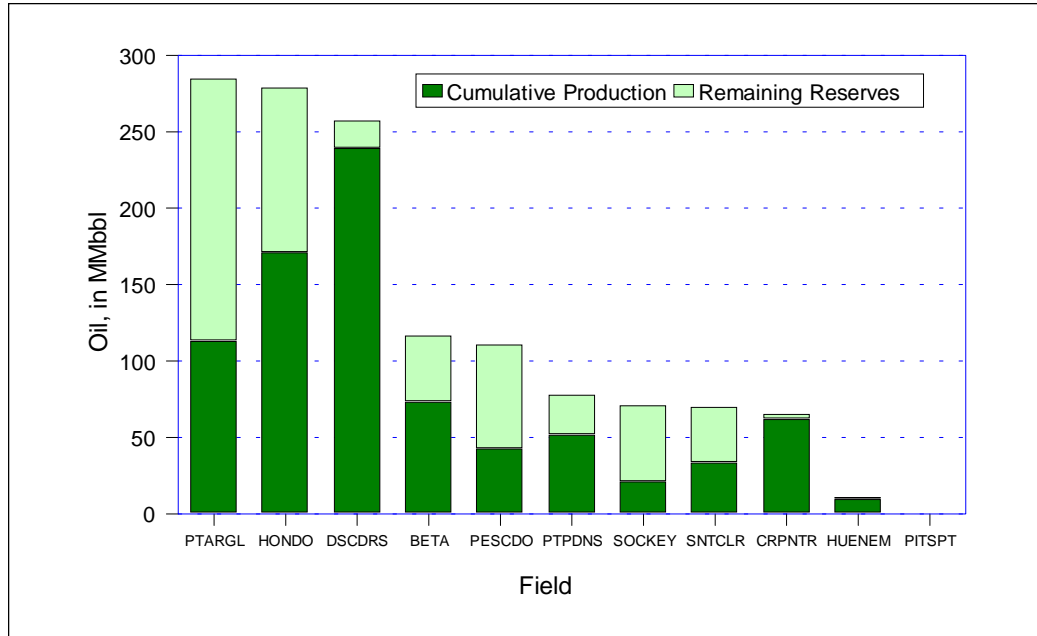
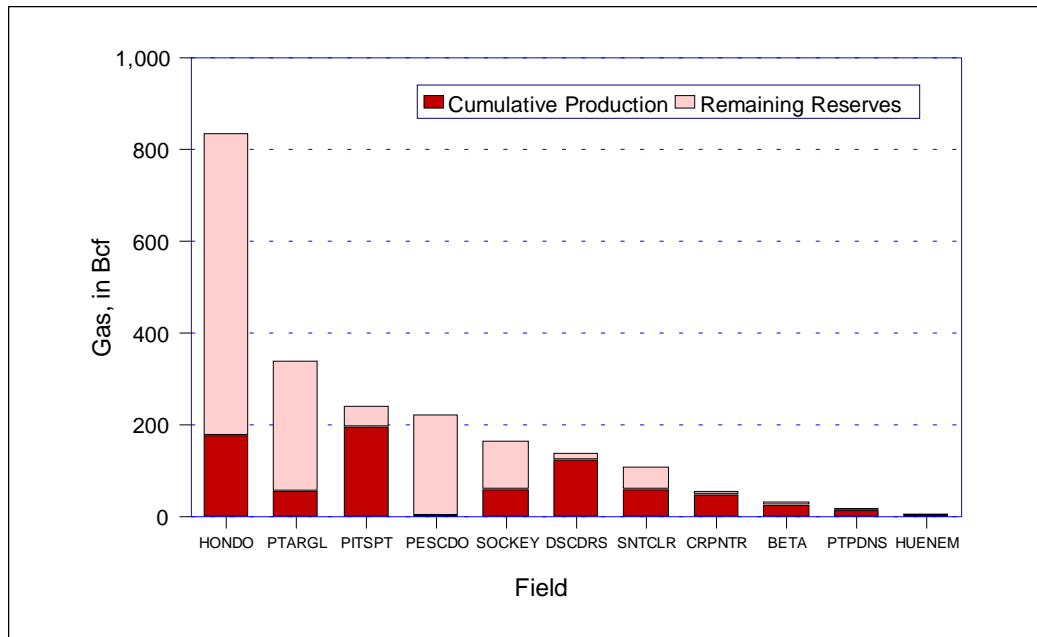


Figure 6.
Production and estimated reserves of gas for producing fields, Pacific OCS.



The current estimate of original recoverable oil reserves is unchanged, as compared with the most recent previous estimate.

The estimate of original recoverable gas reserves has increased slightly, by 225,000 Mcf. In addition, remaining recoverable gas reserve estimates have been adjusted to reflect gas injection volumes for the region. Changes in reported reserves and production in the Pacific OCS are displayed in table 3.

Distribution of Reserves

The field size distribution based on current estimated original recoverable reserves for 27 oil fields, 9 combination oil and gas fields, and 2 gas fields in the Pacific OCS is shown in figure 7. These 38 fields are located in three basins, offshore California. For comparison purposes, gas reserves are expressed in terms of barrels of oil equivalent on the basis of equivalent heating values (5,620 cubic feet of gas has the approximate heating value of 1 bbl of oil), hereinafter referred to as BOE. Producing fields are distinguished from nonproducing fields in this figure.

Approximately two-thirds of the original recoverable oil and gas reserves in the Pacific OCS are attributable to the 11 proved developed fields. These 11 producing fields also contain about one-half of the remaining recoverable reserves.

Gas reserves in the Pacific OCS are located in both oil and gas reservoirs. Approximately one-sixth of the original recoverable and remaining gas reserves occurs as nonassociated gas contained in natural gas reservoirs. The other five-sixths are associated gas contained within oil reservoirs (fig. 8 and table 4).

Oil and gas reserves in the Pacific OCS are further categorized on the basis of the age of the reservoir rocks in which they exist (table 5). The three age groups of reservoir rocks are (1) Pre-Monterey, rocks older than the Monterey Formation (early Miocene age and older); (2) Monterey, rocks of the Monterey Formation (Miocene age); and (3) Post-Monterey, rocks younger than the Monterey Formation (late Miocene age and younger). The distribution of estimated original recoverable and remaining oil and gas reserves by reservoir age group is illustrated in figures 9 and 10.

Seven of the 11 producing fields in the Pacific OCS have substantial reserves attributed to the Monterey Formation, as do 21 of the 27 nonproducing fields. In 18 of the 27 nonproducing fields, all identified reserves are attributed to this formation. Over two-thirds of the original recoverable oil reserves and over three-fourths of the remaining oil reserves are in Monterey Formation reser-

voirs. The Monterey Formation also contains approximately two-thirds of all gas reserves in the Pacific OCS.

Status of Field Development

As of December 31, 1996, 11 of the 38 recognized fields in the Pacific OCS were producing: Point Pedernales, Point Arguello, Pescado, Hondo, Dos Cuadras, Pitas Point, Carpinteria Offshore, Santa Clara, Sockeye, Hueneme, and Beta (fig. 4, fields 7, 11, 20, 23, 29, 30, 31, 33, 34, 36, and 38). Pescado Field became the eleventh producing field in the Pacific OCS when production began from Platform Heritage in December 1993.

Development drilling occurred at 8 of the 11 producing fields during 1996: Point Pedernales, Point Arguello, Pescado, Hondo, Dos Cuadras, Santa Clara, Sockeye, and Beta (fig. 4, fields 7, 11, 20, 23, 29, 33, 34, and 38). The development of Pescado Field and the western portion of Hondo Field continued in 1996 with the drilling of development wells from Platforms Heritage and Harmony. A summary of Pacific OCS development activities during 1996 is presented in appendix B.

Eight producing oil and gas fields in the Pacific OCS are undergoing fluid injection: Point Pedernales, Pescado, Hondo, Dos Cuadras, Carpinteria Offshore, Santa Clara, Sockeye, and Beta (fig. 4, fields 7, 20, 23, 29, 31, 33, 34, and

Figure 7.
Size distribution of
Pacific OCS oil and
gas fields.

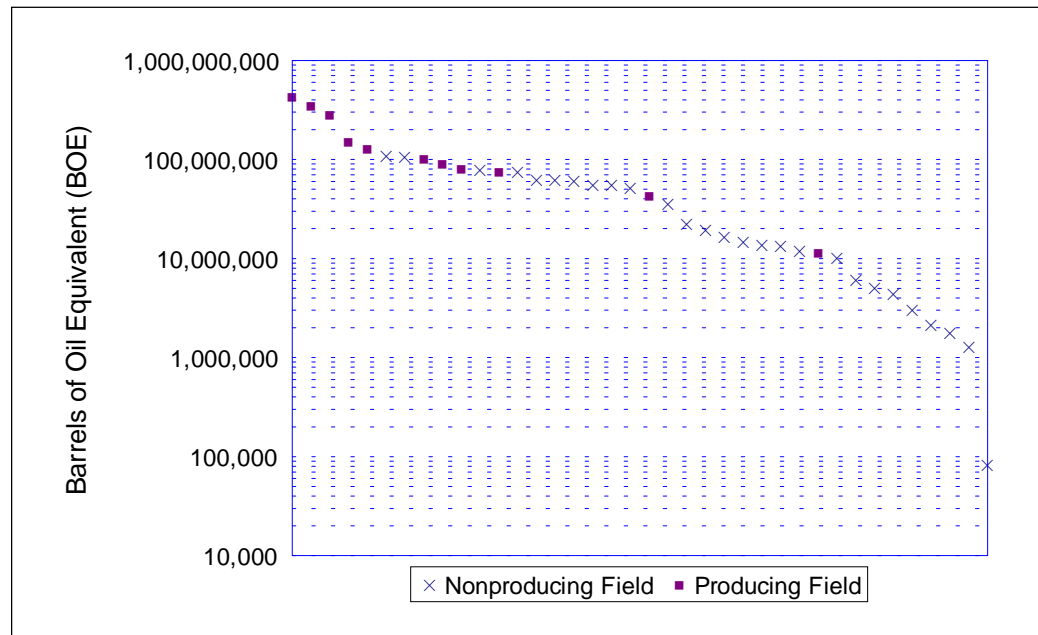


Figure 8.
Production and estimated reserves of gas by type of occurrence, Pacific OCS.

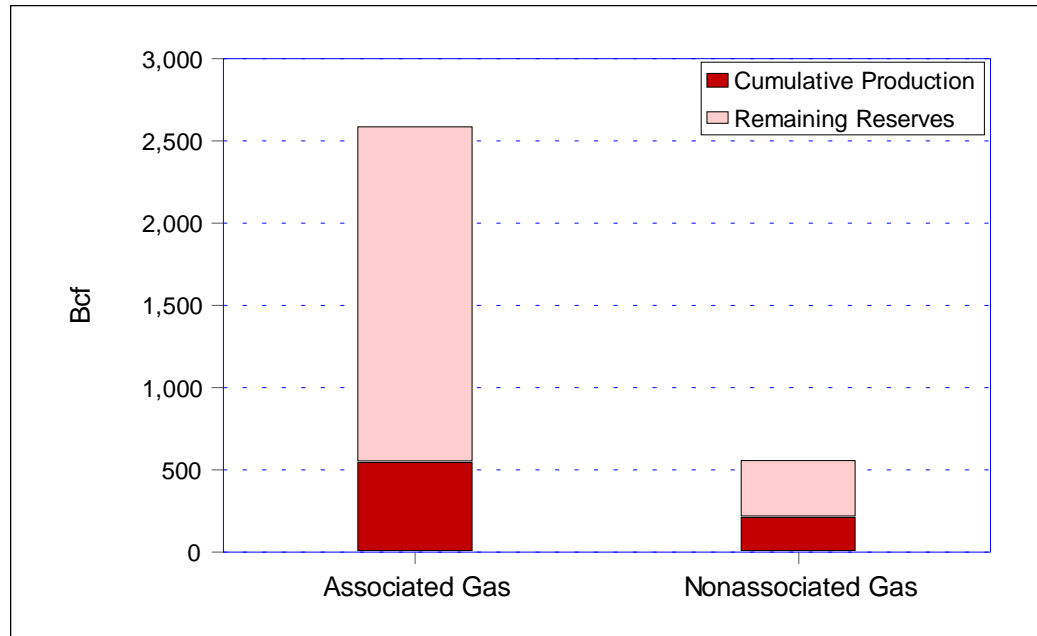


Table 4.
Production and estimated reserves of gas by type of occurrence, Pacific OCS, December 31, 1996

Type of Occurrence	Original Recoverable Reserves (Bcf)	Cumulative Production (Bcf)	1996 Annual Production (Bcf)	Remaining Reserves (Bcf)
Associated	2,585	545	45	2,040
Nonassociated	552	211	5	341
Total	3,136	756	51	2,380

Table 5.
Estimated reserves of oil and gas by reservoir age group, Pacific OCS, December 31, 1996.

Reservoir Age Group	Geologic Formations	Original Recoverable Reserves		Remaining Reserves	
		Oil (MMbbl)	Gas (Bcf)	Oil (MMbbl)	Gas (Bcf)
Post-Monterey	Pico Puente, "Repetto", Santa Margarita, Sisquoc	515	555	120	131
Monterey	Monterey	1,403	1,946	1,018	1,677
Pre-Monterey	Point Sal, Vaqueros, Topanga, Hueneme, Sespe/Alegria, Gaviota, Matilija, Sacate, Juncal (Camino Cielo), Jalama	137	635	103	572

Figure 9.
 Estimated original recoverable and remaining oil reserves by reservoir age group, Pacific OCS.

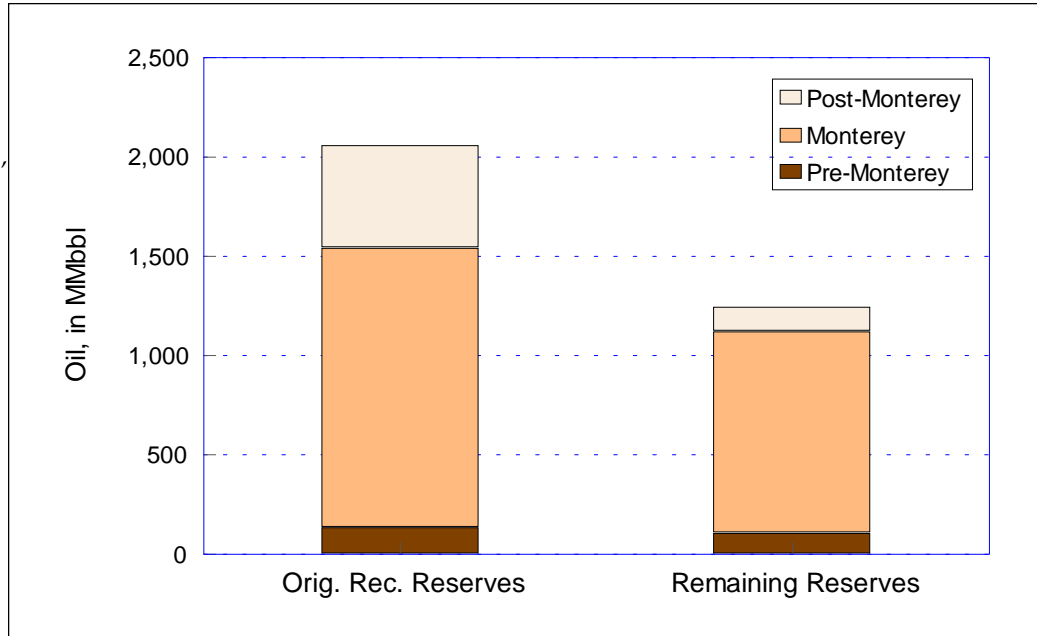


Figure 10.
 Estimated original recoverable and remaining gas reserves by reservoir age group, Pacific OCS.

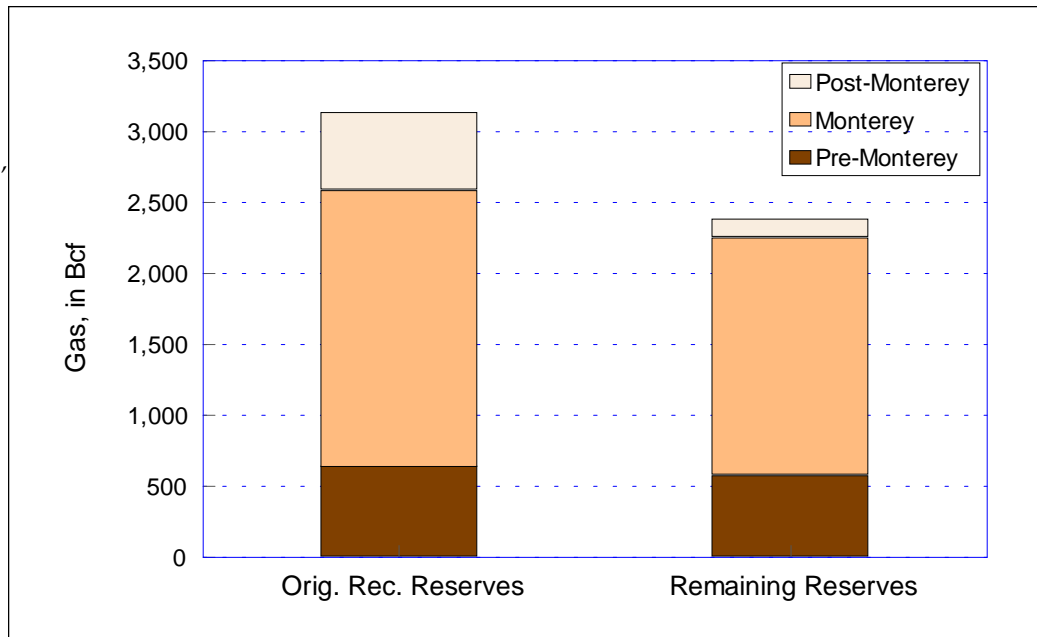


Table 6.
Gas and water injection volumes and rates, Pacific OCS, December 31, 1996.

Field	Gas Injection Volume (Mcf)	Average Gas Injection Rate (Mcfpd)	Water Injection Volume (bbl)	Average Water Injection Rate (bpd)
Beta	0	0	7,995,149	21,845
Carpinteria	18,616	51	0	0
Dos Cuadras	0	0	9,025,951	24,661
Hondo	5,470,530	14,947	0	0
Pescado	12,341,417	33,720	0	0
Pt. Pedernales	74,468	203	0	0
Santa Clara	0	0	1,088,889	2,975
Sockeye	0	0	2,357,962	6,423

38). Recovery beyond primary production is occurring or can be anticipated. Four fields— Point Pedernales, Pescado, Hondo, and Carpinteria Offshore (fig. 4, fields 7, 20, 23, and 31)— are undergoing gas injection for reservoir pressure maintenance or for relief of high pressure gas in emergency situations. Approximately one-fourth of the natural gas produced in the region is reinjected. Table 6 shows water and gas injection volumes and rates for each of the eight fields undergoing injection.

Drilling History and Production Rates

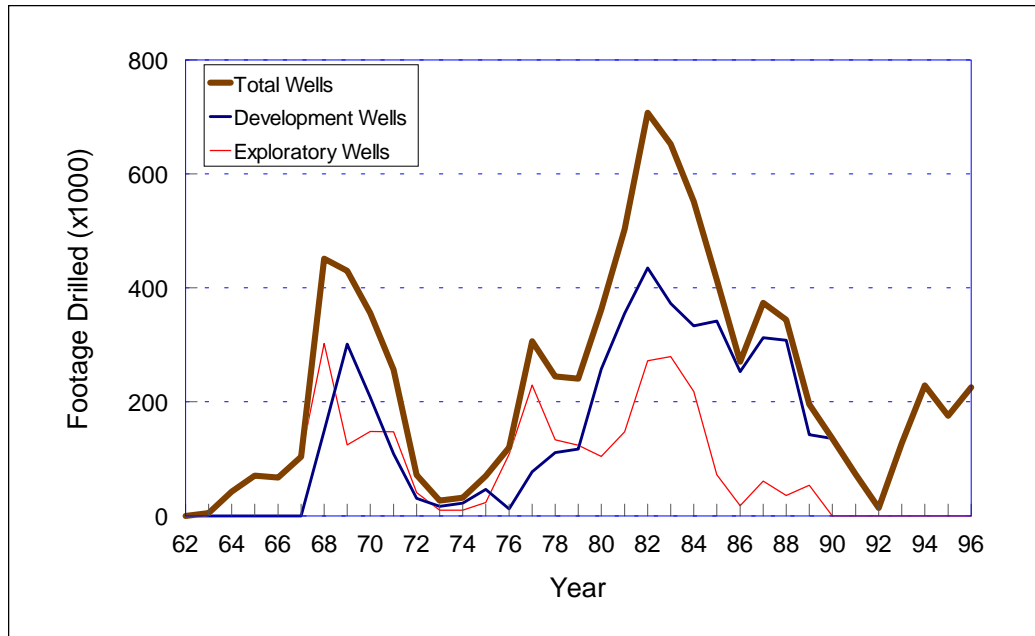
There have been 329 exploratory wells and 825 development wells drilled as of December 31, 1996. For the seventh consecutive year, no exploratory wells were drilled in the Pacific OCS. Thirty development wells and redrills were drilled during 1996, in eight fields. Total footage drilled in these wells exceeded 225,000 feet. Drilled footage by year for all wells in the Pacific OCS is displayed in figure 11. Additional exploratory and delineation wells are anticipated in many of the Pacific OCS fields as the operators seek to define productive limits and optimize oil and gas recovery.

Annual oil production from the Pacific OCS decreased markedly during 1996, to approximately 64 MMbbl of oil. Over five-sixths of the oil was produced from Monterey Formation reservoirs. Most of the other oil production was obtained from reservoirs in rocks younger than the Monterey Formation. The 11 producing fields contributed almost one-sixth of the nation's total OCS oil production. Hondo and Pescado Fields together accounted for over one-half of the region's oil production, and the two fields produced almost one-tenth of the national OCS total.

Net gas production from the 11 producing fields decreased slightly during 1996, with the total approaching 51 Bcf by yearend. Only one gas field was producing at yearend; approximately nine-tenths of the gas production was associated gas obtained from oil reservoirs. Over two-thirds of the gas was produced from Monterey Formation oil reservoirs.

Cumulative production reached approximately 814 MMbbl of oil and 756 Bcf of gas in 1996. About one-half of the oil and gas production in the Pacific OCS to date has been from Post-Monterey aged reservoirs. This proportion will decline, however, as production from Monterey Formation reservoirs continues. Additional oil and gas production volume and rate data for the Pacific OCS are presented in appendix C.

Figure 11.
Annual drilled
footage for wells in
the Pacific OCS.



Oil and Gas Sales Prices, Volumes, and Gravities

During 1996, 11 of the 38 fields in the Pacific OCS produced oil and gas. Sales volumes of oil and gas produced from these fields totaled 63.10 MMbbl and 39.28 Bcf, respectively. The weighted average sales prices of oil and natural gas during 1996 were \$13.81 per barrel and \$1.75 per thousand cubic feet, respectively.

Total sales of crude oil from Pacific OCS oil fields during 1996 are shown in table 7. Pescado Field is the largest field in terms of oil sales volumes. Hondo and Pescado Fields in the Santa Ynez Unit accounted for over one-half of all Pacific OCS crude oil sold.

Total sales of natural gas from each field during 1996 are shown in table 8. Differences between sales volumes and produced gas volumes are due primarily to lease use, flaring, and injection. Pitas Point Field is the only producing gas field in the Pacific OCS, but produced only about one-tenth of all Pacific OCS natural gas sold. Hondo Field produces more natural gas than any other single field in the region. Hondo and Point Arguello Fields account for over one-half of all Pacific OCS natural gas sold.

Oil sales gravities range from 12 to 32 °API. Oil produced from some reservoirs also contains substantial quantities of sulfur and metals. These factors have produced average prices for Pacific OCS crudes that are generally lower than the national average (fig. 12).

Table 7.
Oil sales volumes,
Pacific OCS, 1996.

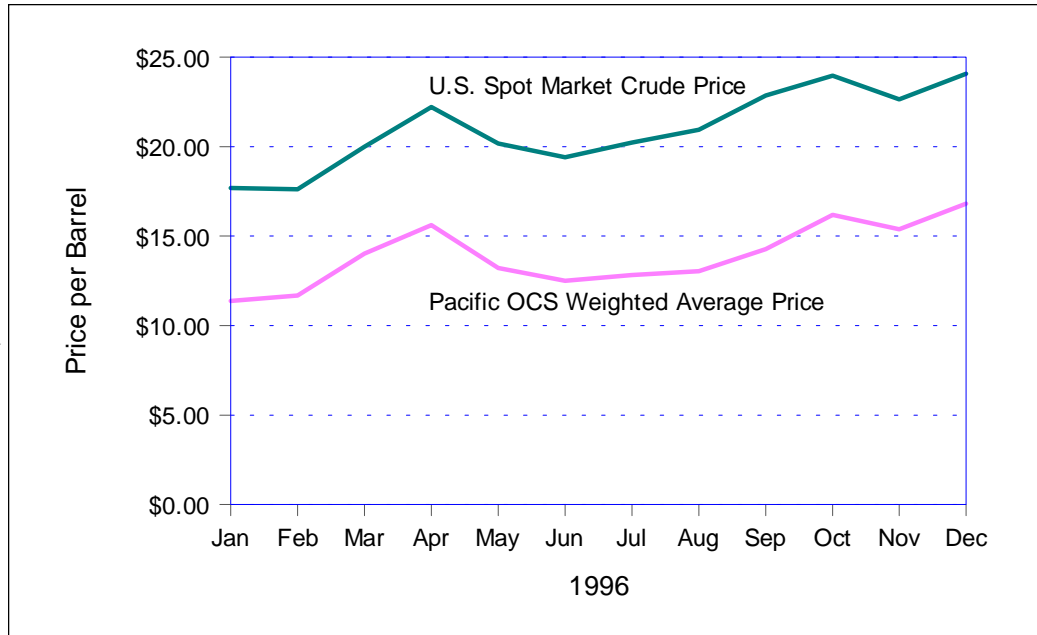
Field	Oil Sales Volume (MMbbl)	Percent of Total Sales
Pescado	21.41	33.93
Hondo	13.49	21.38
Point Arguello	13.14	20.82
Point Pedernales	4.18	6.62
Beta	3.16	5.01
Dos Cuadras	2.79	4.42
Sockeye	2.39	3.79
Santa Clara	1.46	2.31
Carpinteria Offshore	0.79	1.25
Hueneme	0.29	0.47
Total	63.10	100.00

Table 8.
Natural gas sales
volumes, Pacific
OCS, 1996.

Field	Natural Gas Sales Volume (Bcf)	Percent of Total Sales
Hondo	14.33	36.48
Point Arguello	6.48	16.50
Sockeye	5.19	13.21
Pitas Point	5.12	13.03
Dos Cuadras	2.22	5.65
Pescado	2.03	5.17
Point Pedernales	1.85	4.71
Santa Clara	1.21	3.08
Hueneme	0.35	0.89
Carpinteria Offshore	0.32	0.82
Beta	0.18	0.46
Total	39.28	100.00

Figure 12.
Average monthly
crude oil price for
Pacific OCS and
Standard West
Texas Intermediate
Crude (U.S. Spot
Market).

Source: Energy
Information
Administration
*Petroleum Marketing
Monthly, July, 1996.*



Conclusions

As of December 31, 1996, the total original recoverable reserves in 38 fields in the Pacific OCS, offshore California, are estimated to be 2,055 MMbbl of oil and 3,136 Bcf of gas. The remaining proved reserves in 12 oil and gas fields are estimated to be 598 MMbbl of oil and 1,604 Bcf of gas. Unproved reserves in 26 oil and gas fields in the Pacific OCS are estimated to be 643 MMbbl of oil and 776 Bcf of gas. Total remaining oil reserves have decreased by 64 MMbbl, and gas reserves have decreased by 53 Bcf, as compared with previously published estimates.

Oil and gas were being produced from 23 platforms in 11 fields at yearend. Original recoverable gas reserves for the single producing gas field are estimated to be 239 Bcf, and remaining reserves are estimated to be 43 Bcf of gas. Estimated original recoverable reserves for the other 10 producing fields total 1,341 MMbbl of oil and 1,914 Bcf of gas. Estimated remaining reserves for these 10 fields are 527 MMbbl of oil and 1,354 Bcf of gas. Over two-fifths of the remaining oil reserves and over one-half of the remaining gas reserves in the Pacific OCS are contained within producing fields, and approximately three-fourths of the remaining oil and gas reserves are attributed to reservoirs in the Monterey Formation.

Pacific OCS oil production declined during 1996, when approximately 64 MMbbl of oil were produced. Net gas production decreased slightly to about 51 Bcf. Almost nine-tenths of the gas produced during the year was associated gas produced from oil reservoirs. Almost two-thirds of the natural gas produced came from oil reservoirs in the Monterey Formation. Cumulative production from fields in the Pacific OCS has reached 814 MMbbl of oil and 756 Bcf of gas since production began in 1968.

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Appendixes: Reserves, Production, and Development Summaries

The following appendixes provide information on estimated oil and gas reserves, oil and gas production volumes and rates, and annual development activities in the Pacific OCS. This information, obtained primarily from MMS interpretations of geophysical, geological, and other data, form the basis of MMS resource and reserve estimates in the Pacific OCS.

Appendixes

Appendix A- Annual Estimates of Oil and Gas Reserves	A-1
Appendix B- Annual Development Activities	B-1
Appendix C- Annual and Cumulative Oil and Gas Production	C-1

Appendix A - Annual Estimates of Oil and Gas Reserves

The first oil field extending into Federal waters in the Pacific OCS was discovered in 1965. The discovery well was drilled in the State portion of the Carpinteria Offshore Field. Estimates of original recoverable oil and gas reserves in the region have increased since that time, largely due to the discovery of new oil and gas fields and often due to the reevaluation of known fields. Estimates of remaining reserves have generally increased as well, for the same reasons. The continued production of oil and gas, however, following the cessation of leasing and exploratory drilling, has initiated a downward trend in estimates of remaining reserves.

Estimates of Original Recoverable Reserves

Since the discovery of Carpinteria Offshore Field in 1965, estimates of original recoverable oil and gas reserves in the Pacific OCS have increased substantially (fig. A-1 and table A-1). The primary cause for this increase has been the discovery of additional oil and gas fields, many of which are of significant size. Other factors that can increase estimates of original recoverable reserves are the analysis of new data from known fields and the reevaluation of old data in combination with new technology. Past reevaluations of known fields have caused significant increases in estimates of original recoverable reserves.

It should be noted, however, that such studies may result in decreased reserves estimates as well. Some annual estimates of original recoverable oil and gas reserves in the Pacific OCS have decreased, as compared with estimates published in previous years (fig. A-1). The cessation of leasing and exploratory drilling in the Pacific OCS have made the reevaluation of known fields the only factor that continues to change estimates of original recoverable oil and gas reserves.

Estimates of Remaining Reserves

Five of the 38 known fields in the region have been ranked among the top 100 U.S. oil fields in terms of remaining proved reserves; 4 of the 5 have been ranked among the top 50 fields, and 2 of the 5 are in the top 20. One of these fields is also ranked among the 50 largest U.S. gas fields. These 5 fields contain over one-third of the remaining oil reserves and about one-half of the remaining gas reserves in the region. Other Pacific OCS fields may eventually prove to be sufficiently large to be included in the nation's top 100.

Historically, the average volumes of oil and gas produced annually in the Pacific OCS have been about 1 percent of current estimated original recover-

able oil and gas reserves. Such production rates have not caused extreme annual variations between estimated original recoverable reserves and remaining reserves. As a result, annual estimates of remaining oil and gas reserves have generally increased or decreased in step with the annual estimates of original recoverable reserves (figs. A-1 and A-2). The divergence between original recoverable reserves and remaining reserves has increased in recent years, however, as production rates in the Pacific OCS have reached record-setting levels.

Table A-1.
Annual estimates of original recoverable reserves with source publication numbers.

Original Recoverable Reserves			
Year	Publication	Oil (MMbbl)	Gas (Bcf)
1976	OFR 78-384	829	1530
1977	OFR 79-345	843	1546
1978	OFR 80-477	875	1665
1979	OFR 80-1042	920	1845
1980	OFR 81-623	988	1853
1981	OFR 82-37	1082	1847
1982	OFR 83-559	1217	1983
1983	MMS 84-0024	1433	2298
1984	MMS 85-0041	1515	2400
1985	MMS 86-0066	1599	2334
1986	MMS 87-0045	1670	2461
1987	MMS 88-0047	1727	2501
1988	MMS 89-0085	1729	2467
1989	MMS 90-0086	1987	2723
1990	MMS 91-0087	1988	2684
1991	MMS 92-0073	1990	2762
1992	MMS 94-0008	2055	3121
1993	MMS 94-0059	2050	3129
1994	MMS 95-0062	2053	3132
1995	MMS 96-0060	2055	3136
1996	MMS 98-0001	2055	3136

Figure A-1.
Annual estimates
of original
recoverable
reserves from
known fields.

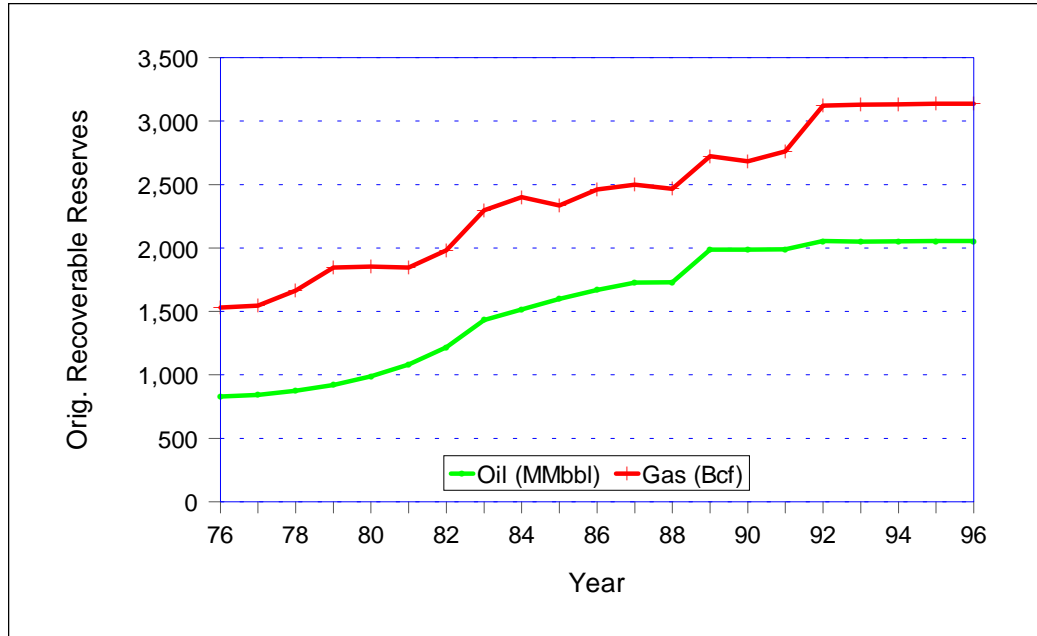
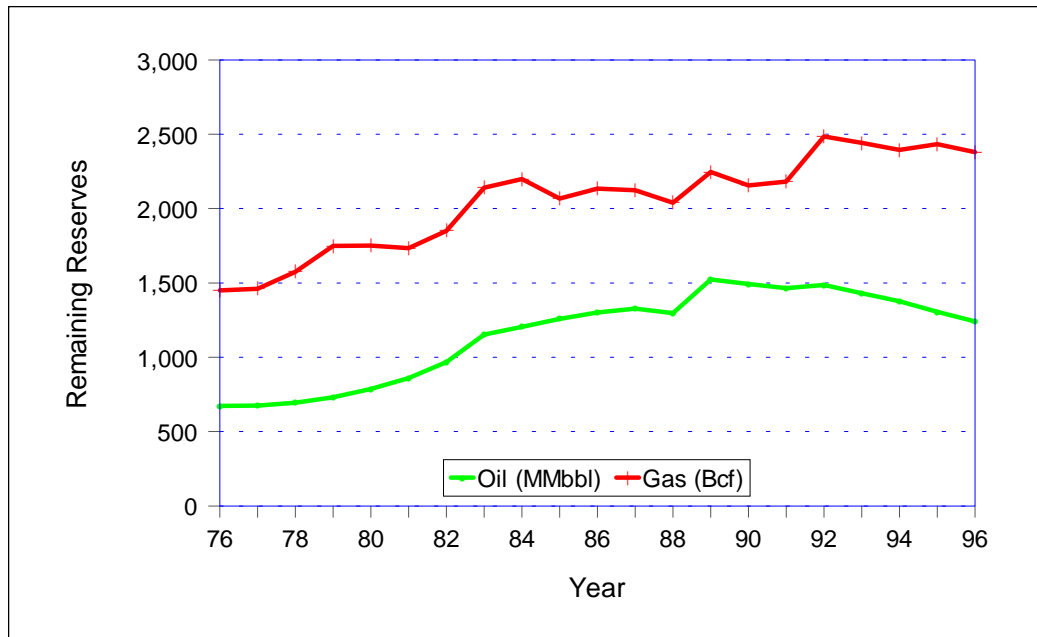


Figure A-2.
Annual estimates
of remaining
recoverable
reserves from
known fields.



Appendix B - Annual Development Activities

The pace of development activities in the Pacific OCS increased during 1996. Only 18 new wells and redrills reached total depth by the end of 1995, but 19 new wells and 11 redrills were drilled in 1996 (tables B-1 and B-2). There was no increase in the number of new completions, however, with 24 in each of the last two years. Other work was also completed at the 11 producing fields.

Field Activities

- Beta Field* Beta Field is the only producing Pacific OCS field in the Los Angeles Basin. Three new development wells were drilled in the field during 1996, and two additional wells were sidetracked. Five wells were converted to artificial lift, and two wells were permanently abandoned. Waterflood operations continued in Leases OCS-P 0300 and 0301. Annual oil and gas production increased to 3,157,498 bbl and 871,609 Mcf, respectively.
- Carpinteria Offshore Field* There were no new development wells drilled at Carpinteria Offshore Field during 1996, but three workovers were conducted by yearend. Workovers included changing two wells to progressive cavity pumps, and converting another well to rod pump. Oil and gas production for the year peaked at 2,373 bpd and 1,514 Mcfpd, respectively, in April. A study of the feasibility of using extended reach drilling to increase productivity and ultimate recovery is continuing.
- Dos Cuadras Field* Torch Operating Company replaced Unocal as the operator of Dos Cuadras Field during 1996. One new well was drilled, and five additional wells were reperforated. Other work included attempts to improve pump performance, control sand production, and reduce "downtime." Although oil production in 1991 averaged only 8,500 bpd, the completion of several trilateral wells had pushed production up to 10,600 bpd by December 1993. Peak oil and gas production during 1996 occurred in May, with average rates of 7,965 bpd and 8,142 Mcfpd, respectively.
- Hondo Field* The development of Hondo Field continued in 1996 with the drilling of five new wells and three redrills. One injection well was converted to a producer, and one well was recompleted in the Monterey Formation. A number of other workovers were also performed. Annual oil and gas production from Hondo Field exceeded 16.7 MMbbl and 21.2 Bcf, respectively, during 1996.
- Hueneme Field* Torch Operating Company became the new operator of Hueneme Field in 1996, taking the place of Unocal. No new wells were drilled during the year. Monthly oil production in 1996 peaked in August at 1,300 bpd. Gas production

peaked the same month at 1,310 Mcfpd. Annual oil production amounted to approximately 308 Mbbl, and gas production for the year exceeded 426 MMcf.

Pescado Field Pescado Field became the eleventh producing field in the Pacific OCS in December 1993. Ten new development wells and sidetracks were drilled and completed from Platform Heritage during 1996. A number of workovers were also performed, including ten acid jobs, eight perforation jobs, and plugging back six wells. Annual oil production totaled about 18.0 MMbbl. Most of the gas produced during 1996 was reinjected, leaving net gas production for the year at just 387,708 Mcf.

Pitas Point Field Pitas Point Field is the only producing gas field in the Pacific OCS. No new wells or redrills were drilled in the field during 1996. Peak gas production for 1996 occurred in May, when daily production averaged 16,732 Mcfpd. Condensate production reached a maximum rate of 14 bpd the same month.

Point Arguello Field The field was unitized in October, 1996, with Chevron designated as the unit operator for all three platforms. Only one redrill was completed in Point Arguello Field during 1996. Ten wells had perforations added in the Monterey Formation, while 17 wells had perforations plugged back. Six wells in Point Arguello Field were acidized, and two artificial lift jobs were completed. Annual oil production from the field approached 15 MMbbl, while gas production for the year exceeded 10 Bcf.

Point Pedernales Field One new development well was drilled in Point Pedernales Field during 1996. Perforations were added to one well, and one well was acidized. Oil production from Point Pedernales Field approached 4.2 MMbbl in 1996. Net gas production for the year was approximately 1.9 Bcf.

Santa Clara Field One new well and one redrill were drilled in Santa Clara Field during 1996. Acid jobs were performed on eight wells, six of which were injection wells. The operator temporarily abandoned ten shut-in production wells. Annual oil and gas production from the field continued to decline, to approximately 1.5 MMbbl and 1.3 Bcf, respectively.

Sockeye Field Two new development wells were drilled from Platform Gail in Sockeye Field during 1996. Perforations were added in three wells in the Monterey and Sespe Formations. Four producing wells were acidized, and workovers were performed on two wells to reduce sand production. Annual oil production totaled over 2.3 MMbbl, with gas production during 1996 reaching approximately 5.9 Bcf.

Table B-1.
Summary of development well borehole status at yearend, 1996.

Platform Name	APD	ACT	DSI	COM	PA	ST	TA	Total
A				50		15		65
B				53	1	21		75
C	1			33				34
Edith				18		1	2	21
Ellen				61	4	7		72
Eureka				49	1	1		51
Gail				21	1			22
Gilda	1			59	3	8	2	73
Gina				12	2			14
Grace				3	2	7	17	29
Habitat				18	1		2	21
Harmony				19				19
Harvest				18			1	19
Henry				23	1	1		25
Heritage				23		5		28
Hermosa				11		2		13
Hidalgo				10	1			11
Hillhouse				47	4			51
Hogan				36	4	10		50
Hondo				27	1	11		39
Houchin				55	4	8	1	68
Irene				21	2	3	1	27
Total	2			667	32	100	26	827

Table B-2.
Summary of
development well
completion status
at yearend, 1996.

Platform Name	POW	GLO	PGW	OSI	GSI	GIW	WIW	WDW	WSW	Total
A	35			11			6	1		53
B	34			15			8			57
C	23			5			11			39
Edith	15			3						18
Ellen	24			10	2	1	22		3	62
Eureka	31		1	1			15	1		49
Gail	2	23	4							29
Gilda	35		1	7	4		16			63
Gina	3			4			5			12
Grace		9								9
Habitat			10		10					20
Harmony		19	1							20
Harvest	5	9		4						18
Henry	18			5						23
Heritage		20		1		2				23
Hermosa	2	10								12
Hidalgo		10								10
Hillhouse	11	28		7			1	1		48
Hogan	8	6		17		2		3		36
Hondo	3	21		1		1	1	1		28
Houchin	32	5		18						55
Irene	0	21								21
Total	281	181	17	109	16	6	85	7	3	705

Appendix C - Annual and Cumulative Oil and Gas Production

Oil and gas production from the Pacific OCS began in June 1968 from Carpinteria Offshore Field. By December 31, 1996, 10 additional fields were producing oil and gas. Peak gas production in the region occurred in 1985, when nearly 64 Bcf of gas were produced. The most oil produced from the Pacific OCS in a single year was over 72 MMbbl, in 1995. To date, approximately 814 MMbbl of oil and 756 Bcf of gas have been produced from 11 fields. Cumulative production equals about two-fifths of the original recoverable oil reserves and one-fourth of the original recoverable gas reserves.

Annual Production

Oil production from the Pacific OCS reached a peak during 1995, when approximately 72 MMbbl of oil were produced. Production declined during 1996, to about 64MMbbl (table C-1, and figs. C-1 and C-2). This amount, produced from only 23 platforms in 11 fields, represents almost one-sixth of the Nation's OCS oil production for the year.

Net gas production from the Pacific OCS had also decreased by yearend, to less than 51 Bcf. Gas production from Pitas Point Field, the only producing gas field in the region, continued to decline during 1996, as did gas production from Point Arguello and Sockeye Fields. Hondo Field produced significantly more gas during 1996. Production from these four fields exceeded 42 Bcf, accounting for three-fourths of the gas produced in the Pacific OCS.

During 1996, over four-fifths of the oil and two-thirds of the gas were produced from reservoirs in the Monterey Formation (fig. C-3). Reservoirs in younger rocks were the source of most of the remaining production. The proportion of produced oil and gas obtained from Monterey Formation reservoirs will increase as production from Point Arguello, Hondo, and Pescado Fields continues.

Cumulative Production

Cumulative production exceeded 814 MMbbl of oil and 756 Bcf of gas in 1996 (table C-1 and fig. C-4). The amount of oil produced to date is almost three-fifths of the proved original recoverable reserves and two-fifths of the total original recoverable reserves. The cumulative gas production estimate has been adjusted to reflect gas reinjection in the region; net gas production to date equals almost one-third of the proved original recoverable reserves and almost one-fourth of the total original recoverable reserves.

Dos Cuadras Field has produced more oil than any other field in the Pacific OCS. Almost one-third of the region's cumulative oil production can be attributed to Dos Cuadras Field. Over one-half of the cumulative oil production can be attributed to just two fields, Dos Cuadras and Hondo. Dos Cuadras, Hondo, Point Arguello, and Beta Fields have contributed about three-fourths of the oil produced to date.

Net gas production from Pitas Point Field, the only producing gas field in the Pacific OCS, exceeds that from any other field in the region. Hondo Field currently ranks second in terms of cumulative gas production. The combined total gas production from the two fields amounts to approximately one-half of the cumulative gas production from the region. Hondo, Pitas Point, and Dos Cuadras Fields have produced about two-thirds of the natural gas obtained from Pacific OCS fields.

About one-half of the oil and gas produced to date can be attributed to Post-Monterey reservoirs (fig. C-5). Production from Monterey Formation reservoirs continues to increase, however, and almost one-half of the oil and over one-third of the gas produced by December 31, 1996, has been obtained from reservoirs in the Monterey Formation.

Year	Annual Oil (bbl)	Cumulative Oil (bbl)	Annual Gas (Mcf)*	Cumulative Gas (Mcf)*
1968	2,076,160	2,076,160	1,237,180	1,237,180
1969	9,942,733	12,018,893	6,016,485	7,253,665
1970	25,035,171	37,054,064	13,757,148	21,010,813
1971	31,103,681	68,157,745	17,853,055	38,863,868
1972	22,562,566	90,720,311	12,546,915	51,410,783
1973	18,818,026	109,538,337	9,157,714	60,568,497
1974	16,784,100	126,322,437	7,234,937	67,803,434
1975	15,434,507	141,756,944	5,978,959	73,782,393
1976	13,977,436	155,734,380	5,533,258	79,315,651
1977	12,258,013	167,992,393	5,366,181	84,681,832
1978	11,979,674	179,972,067	5,193,985	89,875,817
1979	10,971,013	190,943,080	5,430,689	95,306,506
1980	10,118,614	201,061,694	5,771,792	101,078,298
1981	19,619,670	220,681,364	12,769,110	113,847,408
1982	28,471,665	249,153,029	17,814,958	131,662,366
1983	30,558,866	279,711,895	23,923,258	155,585,624
1984	30,500,506	310,212,401	45,912,435	201,498,059
1985	29,673,649	339,886,050	63,523,094	265,021,153
1986	28,779,936	368,665,986	57,989,035	323,010,188
1987	31,284,618	399,950,604	54,874,298	377,884,486
1988	31,529,776	431,480,380	49,132,759	427,017,245
1989	33,067,789	464,548,169	50,872,623	477,889,868
1990	29,885,271	494,310,184	49,950,216	527,796,524
1991	31,623,014	525,896,641	52,390,640	580,197,225
1992	42,711,426	568,610,886	55,268,116	635,258,278
1993	50,656,382	619,321,164	51,832,124	687,459,521
1994	58,244,162	677,582,722	50,892,378	738,337,427
1995	72,435,648	749,972,392	51,064,173	792,577,637
1996	64,297,429	814,271,114	50,637,201	843,214,838

Table C-1.
Annual and cumulative production for the Pacific OCS.

*** Note:**
Beginning in 1995 gas volumes have been adjusted to account for reinjected gas.

Year	Annual Oil (bbl)	Cumulative Oil (bbl)	Annual Gas (Mcf)*	Cumulative Gas (Mcf)*
1968	2,076,160	2,076,160	1,237,180	1,237,180
1969	9,942,733	12,018,893	6,016,485	7,253,665
1970	25,035,171	37,054,064	13,757,148	21,010,813
1971	31,103,681	68,157,745	17,853,055	38,863,868
1972	22,562,566	90,720,311	12,546,915	51,410,783
1973	18,818,026	109,538,337	9,157,714	60,568,497
1974	16,784,100	126,322,437	7,234,937	67,803,434
1975	15,434,507	141,756,944	5,978,959	73,782,393
1976	13,977,436	155,734,380	5,533,258	79,315,651
1977	12,258,013	167,992,393	5,366,181	84,681,832
1978	11,979,674	179,972,067	5,193,985	89,875,817
1979	10,971,013	190,943,080	5,430,689	95,306,506
1980	10,118,614	201,061,694	5,771,792	101,078,298
1981	19,619,670	220,681,364	12,769,110	113,847,408
1982	28,471,665	249,153,029	17,814,958	131,662,366
1983	30,558,866	279,711,895	23,923,258	155,585,624
1984	30,500,506	310,212,401	45,912,435	201,498,059
1985	29,673,649	339,886,050	63,523,094	265,021,153
1986	28,779,936	368,665,986	57,989,035	323,010,188
1987	31,284,618	399,950,604	54,874,298	377,884,486
1988	31,529,776	431,480,380	49,132,759	427,017,245
1989	33,067,789	464,548,169	50,872,623	477,889,868
1990	29,885,271	494,310,184	49,950,216	527,796,524
1991	31,623,014	525,896,641	52,390,640	580,197,225
1992	42,711,426	568,610,886	55,268,116	635,258,278
1993	50,656,382	619,321,164	51,832,124	687,459,521
1994	58,244,162	677,582,722	50,892,378	738,337,427
1995	72,435,648	749,972,392	51,064,173	702,577,637
1996	64,297,429	814,271,114	50,637,201	756,114,009

Figure C-1.
Annual production
for the Pacific OCS.

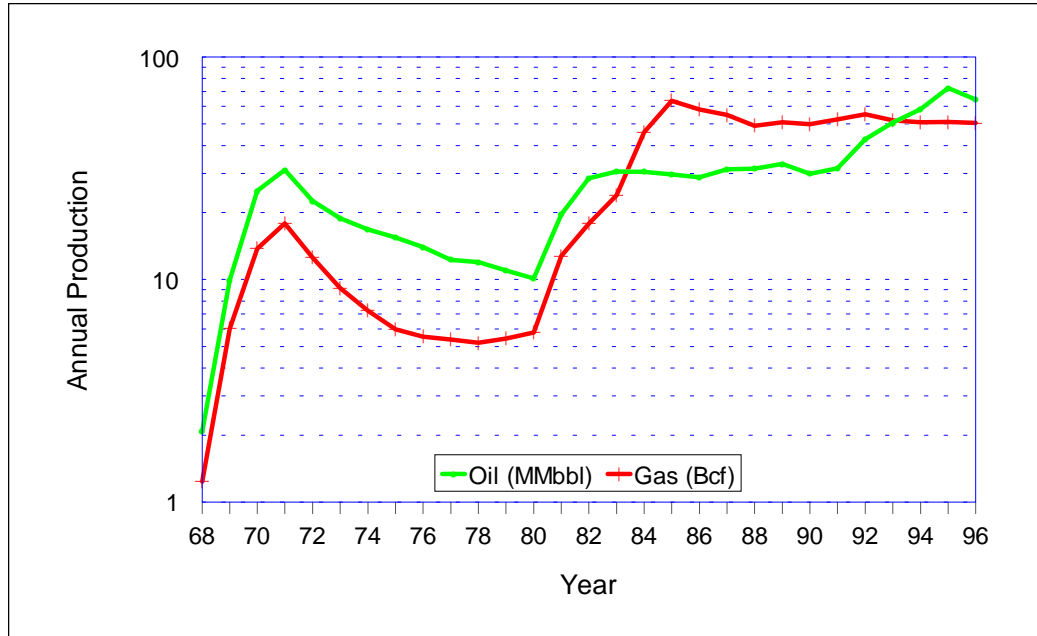


Figure C-2.
Average daily
production for the
Pacific OCS.

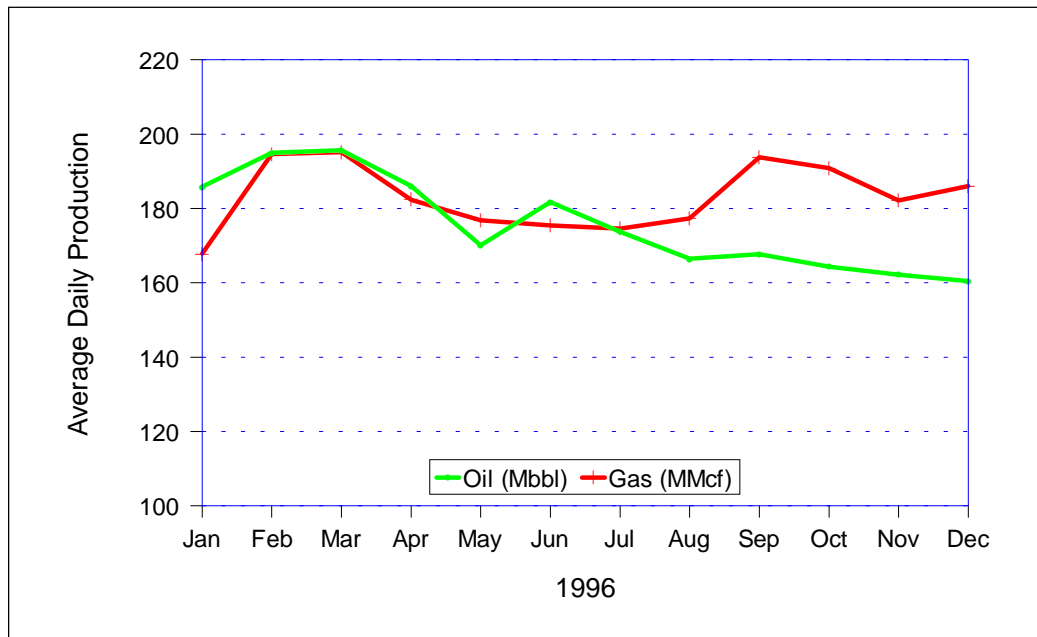


Figure C-3.
Annual production
of oil and gas by
reservoir age group,
Pacific OCS, Dec.
31, 1996.

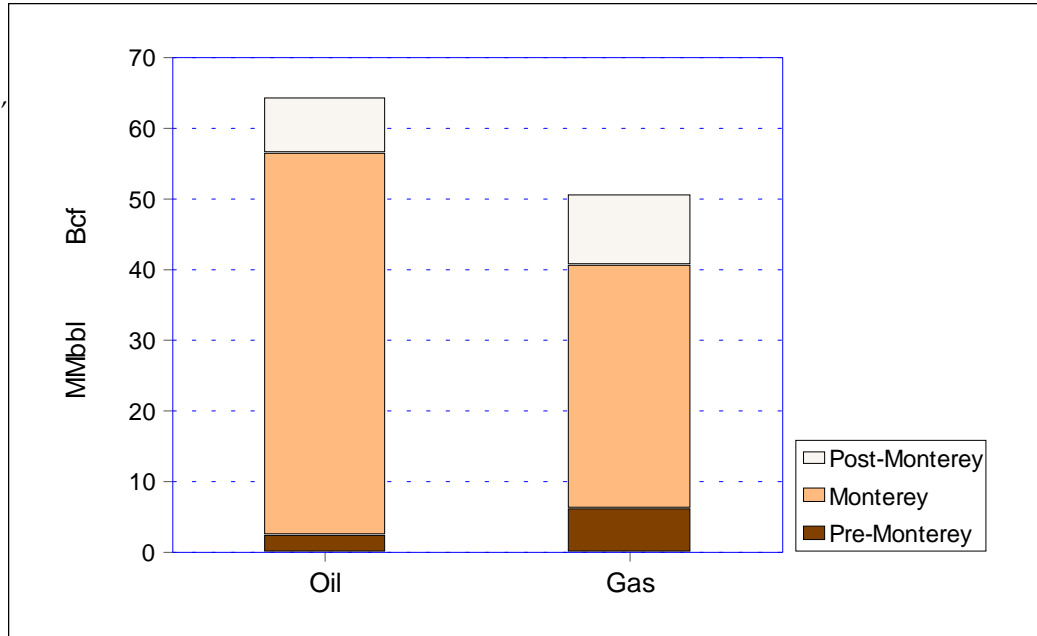


Figure C-4.
Cumulative
production for the
Pacific OCS.

***Note:**
Beginning in 1995
gas volumes have
been adjusted to
account for
reinjecting gas.

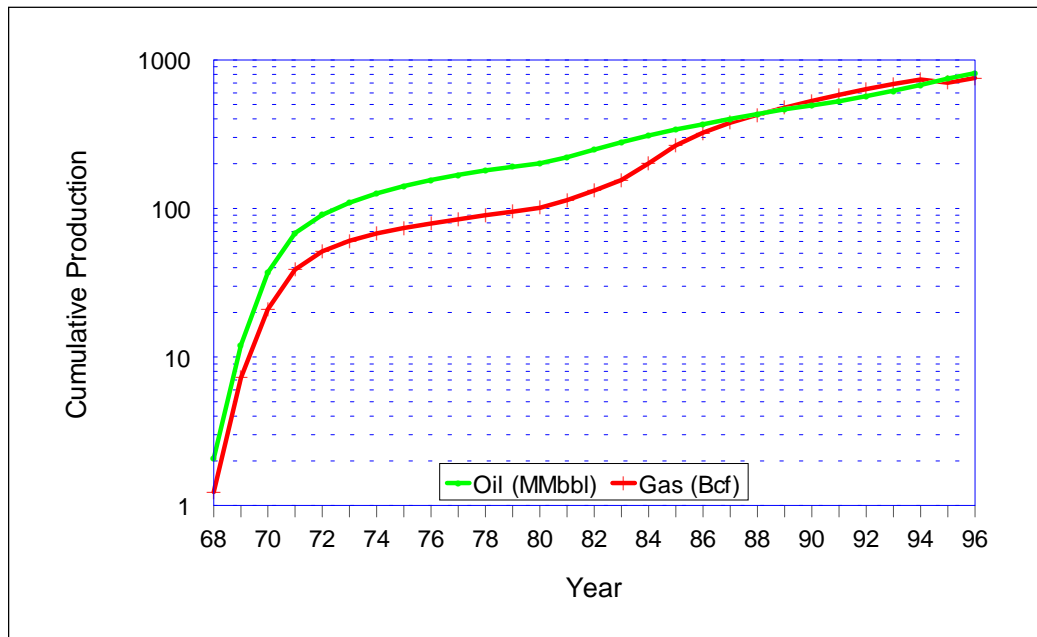
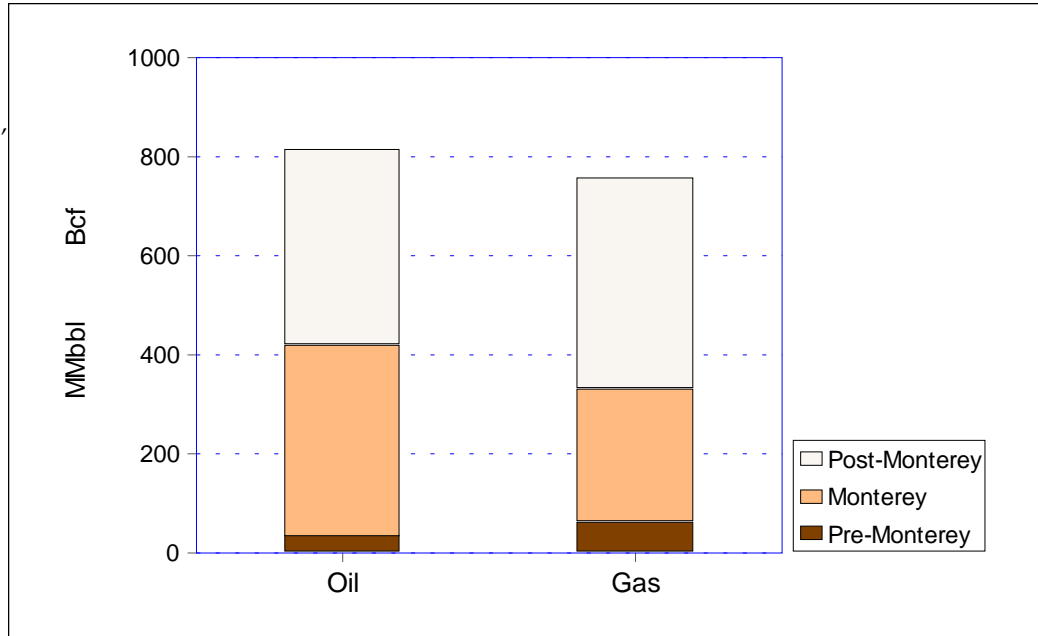


Figure C-5.
Cumulative
production of oil
and gas by
reservoir age group,
Pacific OCS,
December 31, 1996.





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 Royalty Management Program** 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.