

Estimated Oil and Gas Reserves Pacific Outer Continental Shelf

(as of December 31, 1997)



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COVER PHOTO: Chevron's Platform Hidalgo, which was installed in 1986 in 430 feet of water. Wells drilled from this 56-slot platform have been producing oil and gas from Point Arguello Field in the southern Santa Maria Basin since May 1991. *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 US 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
RD	Redrill
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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and Armen Voskanian

Abstract

Proved reserves of oil¹ and gas² in the Pacific Outer Continental Shelf (OCS), offshore California, are estimated to be 486 million barrels and 1,412 billion cubic feet, respectively, as of December 31, 1997. These reserves are attributed to 12 fields. Original recoverable oil and gas reserves for these fields are estimated to be 1,355 million barrels and 2,231 billion cubic feet, respectively. Unproved reserves are estimated to be 1,315 million barrels of oil and 910 billion cubic feet of gas, in 25 fields.

Reserve estimates for 30 of the 37 Pacific OCS fields were calculated using individual reservoir volumetric studies. Both decline-curve and volumetric analyses were used for the remaining 7 fields. Over three-fourths of all oil reserves and approximately two-thirds of all gas reserves are attributed to reservoirs in the Monterey Formation. Almost three-fourths of the remaining oil reserves are contained within fields that have not yet been developed.

Eleven of the 37 fields were producing at yearend. Oil production during 1997 approached 55 million barrels. Over 77 billion cubic feet of gas were produced during 1997, of which approximately 23 billion cubic feet were reinjected. To date, approximately 869 million barrels of oil and 819 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 98-0001 (Sorensen and others, 1997), presents estimates of original recoverable oil and gas reserves, cumulative production through 1997, and estimates of remaining reserves as of December 31, 1997, for the Pacific Outer Continental Shelf (OCS), offshore California. These estimates were completed in February 1999. 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.

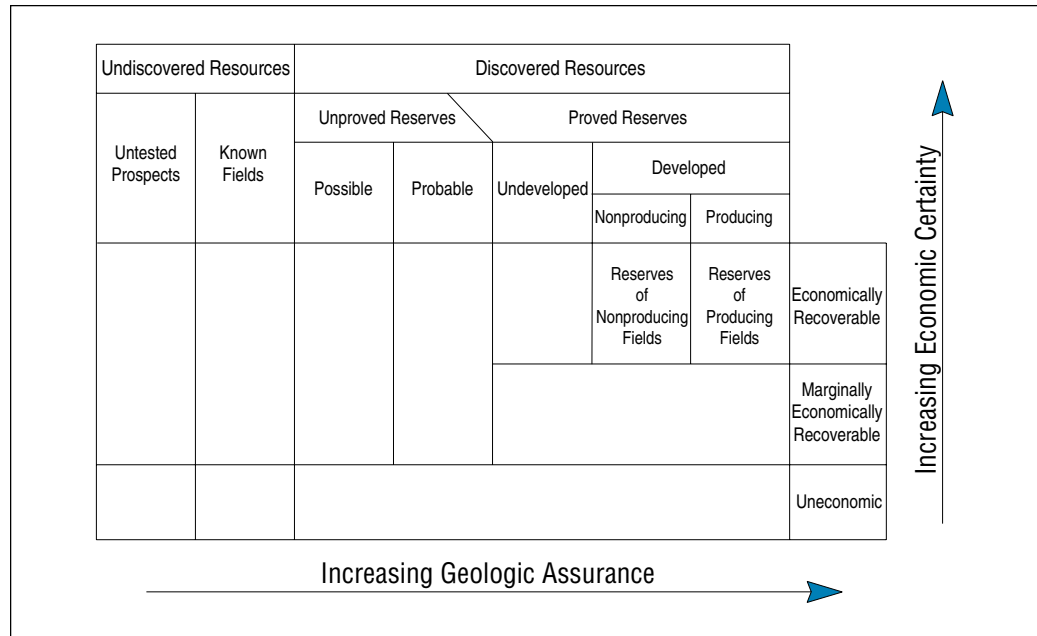
The estimates presented here were prepared by petroleum engineers, geologists, geophysicists, and other personnel from the MMS Pacific OCS Regional Office, Camarillo, California. Previous reserves reports were used as a basis for parts of this update.

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 250.111), the lease is considered to have discovered resources. Discovered resources are

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



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 250.111.

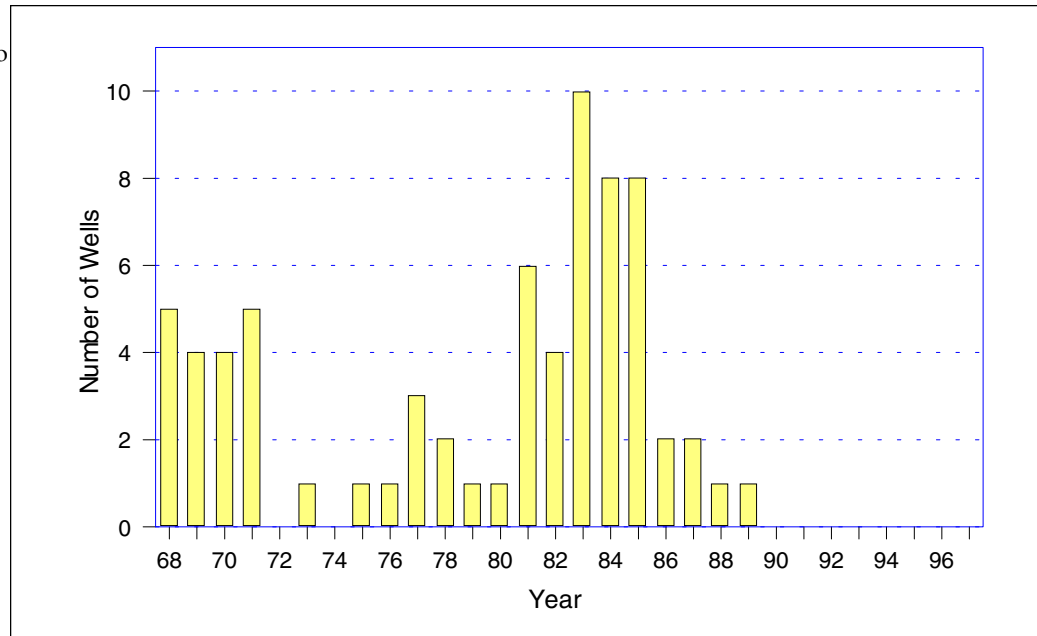
Unproved Reserves

After a lease qualifies under 30 CFR 250.111, 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 commercial” (SPE, 1987). After a lease qualifies under 30 CFR 250.111, the

Figure 2.
Wells determined to be producible in accordance with 30 CFR 250.111, Pacific OCS.



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 to be on production. If a reservoir had sustained production during the last year, it is considered to contain proved developed producing reserves.

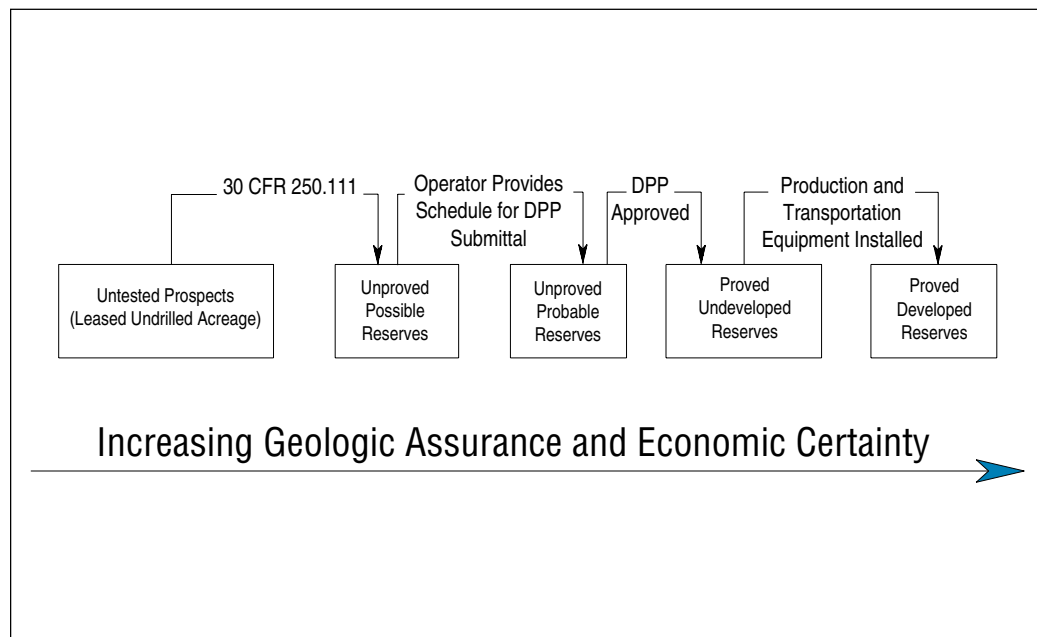
Any developed reservoir in a developed field that has not produced or has not had sustained production during the past year is considered to contain *proved developed nonproducing reserves*. This category includes reserves contained in nonproducing reservoirs, reserves contained behind-pipe, and reservoirs 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 measurements and reserves are corrected to reference standard conditions of

Figure 3.
MMS Pacific OCS
reserves
classification
procedure.



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, 1997, there are 37 fields in the Pacific OCS that are recognized as containing reserves under the established criteria. Two of these fields are gas fields, 26 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 6, 10, 19, 20, 22, 28, 29, 30, 32, 33, 35, and 37). All of these fields, with the exception of Sacate, were producing at yearend. The remaining 25 fields were determined to have unproved hydrocarbon reserves.

Reserves 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 22,

28, 29, 30, 32, 35, and 37). Individual reservoirs in each field were grouped for volumetric calculations, while decline-curve analyses were made on lease-by-lease and platform bases. The 30 remaining fields (4 producing and 26 nonproducing) were studied on a reservoir-by-reservoir basis, and the reserves estimates were determined solely by the volumetric calculation method.

Estimated Oil and Gas Reserves

As of December 31, 1997, total original recoverable oil and gas reserves in the Pacific OCS are estimated to be 2,670 million barrels (MMbbl) and 3,141 billion cubic feet (Bcf), respectively. Total remaining reserves are estimated to be 1,801 MMbbl of oil and 2,322 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. Changes in reported reserves and production in the Pacific OCS are displayed in table 3.

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, 1997.

Reserves Category	Number of Fields	Original Recoverable Reserves		Cumulative Production		Annual Production		Remaining Reserves	
		Oil (MMbbl)	Gas (Bcf)	Oil (MMbbl)	Net Gas (Bcf)	Oil (MMbbl)	Net Gas (Bcf)	Oil (MMbbl)	Gas (Bcf)
Proved Developed	11	1,283	2,023	869	819	55	54*	415	1,204
Proved Undeveloped	1	71	208	0	0	0	0	71	208
Unproved Possible - Active Leases	13	1,178	559	0	0	0	0	1,178	559
Unproved Possible - Expired Leases	12	138	351	0	0	0	0	138	351
Total	37	2,670	3,141	869	819	55	54*	1,801	2,322

* Net gas volume (minus loss and reinjection); gross gas volume produced = 77 Bcf

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.)

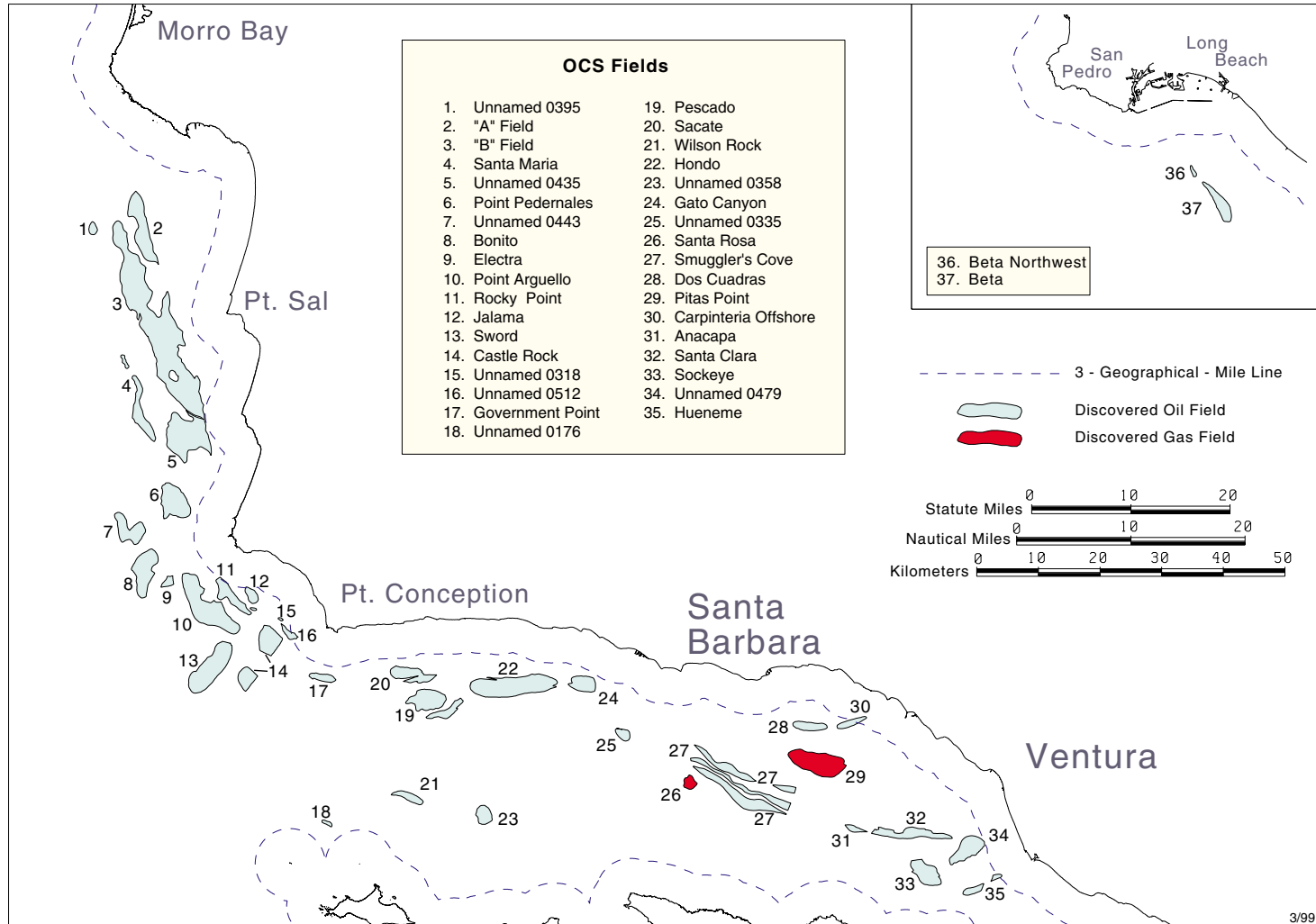


Table 2.
Production and estimated reserves of oil and gas for producing fields, Pacific OCS, December 31, 1997

Field	Original Recoverable Reserves		Cumulative Production		1997 Annual Production		Remaining Reserves	
	Oil (MMbbl)	Gas (Bcf)	Oil (MMbbl)	Net Gas (Bcf)	Oil (MMbbl)	Net Gas (Bcf)	Oil (MMbbl)	Gas (Bcf)
Beta	117.60	33.50	76.06	24.58	3.04	1.02	41.54	8.92
Carpinteria	65.20	55.00	62.26	52.29	0.79	0.58	2.94	2.71
Dos Cuadras	256.80	137.60	241.69	125.32	2.60	2.69	15.11	12.28
Hondo	278.90	834.02	187.13	204.03	16.24	25.59	91.77	629.99
Hueneme	10.57	5.30	9.69	3.95	0.28	0.29	0.88	1.35
Pescado	110.79	222.32	57.07	7.47	14.89	5.82	53.72	214.85
Pitas Point	0.27	239.22	0.19	200.56	0.01	4.41	0.07	38.65
Point Arguello	225.00	155.33	122.88	62.86	10.28	5.99	102.12	92.47
Point Pedernales	77.30	25.50	54.74	13.93	3.08	1.09	22.56	11.57
Santa Clara	70.13	109.37	34.49	60.57	1.18	0.90	35.64	48.80
Sockeye	70.83	206.12	22.49	63.03	2.13	5.79	48.34	143.09
Total	1,283.39	2023.28	868.77	818.59	54.51	54.16*	414.62	1,204.69

* Net gas volume (minus loss and reinjection); gross gas volume produced = 77 Bcf

Table 3.
Changes in reported reserves and production, Pacific OCS, December 31, 1997.

Production and Reserves	Oil (MMbbl)	Gas (Bcf)
Original Recoverable Reserves:		
Estimated as of 12/31/97 (This Report)	2,670	3,141
Estimated as of 12/31/96 (MMS 98-0001)	2,055	3,136
Change	+615	+5
Cumulative Production:		
Through 1997	869	819
Through 1996	814	756
Proved Reserves:		
Estimated as of 12/31/97 (This Report)	486	1,412
Estimated as of 12/31/96 (MMS 98-0001)	598	1,604
Change	-112	-192
Total Reserves:		
Estimated as of 12/31/97 (This Report)	1,801	2,322
Estimated as of 12/31/96 (MMS 98-0001)	1,241	2,380
Change	+560	-58

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

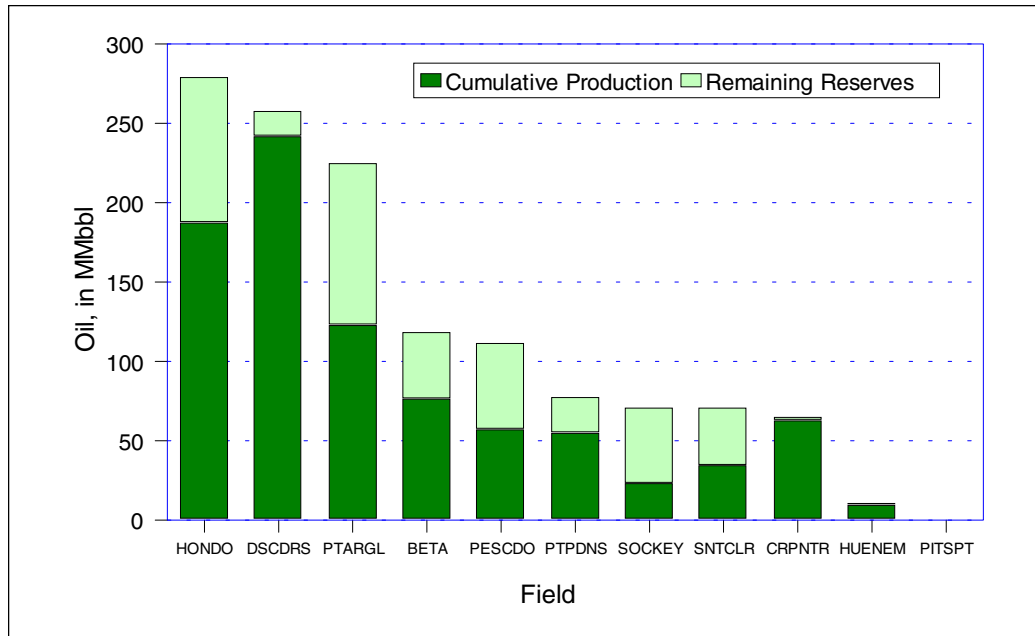
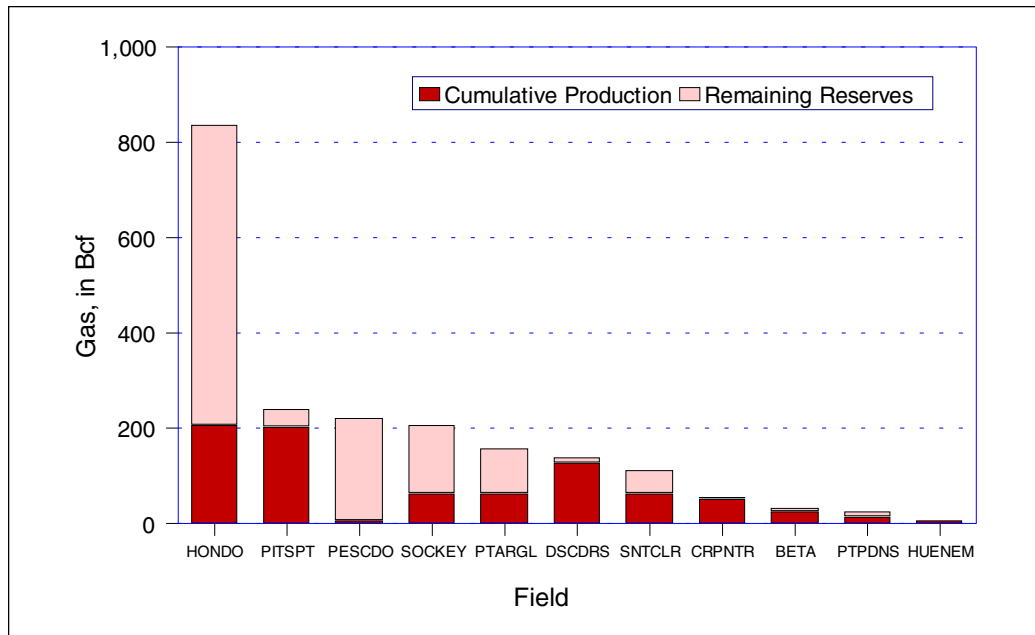


Figure 6.
Production and estimated reserves of gas for producing fields, Pacific OCS.



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

The estimate of original recoverable gas reserves has increased slightly, by about 5 Bcf. In addition, remaining recoverable gas reserve estimates have been adjusted to reflect gas injection volumes for the region.

Distribution of Reserves

The field size distribution based on current estimated original recoverable reserves for 26 oil fields, 9 combination oil and gas fields, and 2 gas fields in the Pacific OCS is shown in figure 7. These 37 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 one-half of the original recoverable oil reserves and two-thirds of the original gas reserves in the Pacific OCS are attributable to the 11 proved developed fields. These 11 producing fields also contain about one-fourth of the remaining recoverable oil reserves and one-half of the remaining recoverable gas 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 26 nonproducing fields. In 17 of the 26 nonproducing fields, all identified reserves are attributed to this formation. Over three-quarters of the original recoverable oil reserves and

almost nine-tenths of the remaining oil reserves are in Monterey Formation reservoirs. The Monterey Formation also contains approximately two-thirds of all gas reserves in the Pacific OCS.

Status of Field Development

As of December 31, 1997, 11 of the 37 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 6, 10, 19, 22, 28, 29, 30, 32, 33, 35, and 37). Pescado Field became the eleventh producing field in the Pacific OCS when production began from Platform Heritage in December 1993.

Development drilling occurred at 7 of the 11 producing fields during 1997: Point Pedernales, Point Arguello, Pescado, Hondo, Dos Cuadras, Santa Clara, Sockeye, and Beta (fig. 4, fields 6, 10, 19, 22, 28, 32, and 37). The development of Pescado Field and the western portion of Hondo Field continued in 1997 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 Off-

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

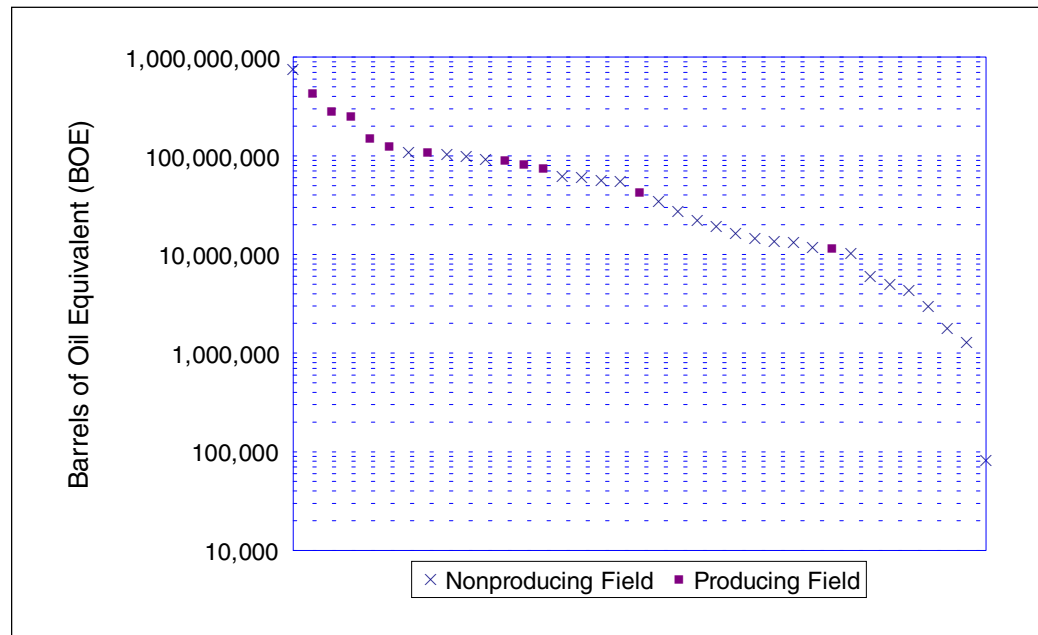


Figure 8.
Production and estimated reserves of gas by type of occurrence, Pacific OCS.

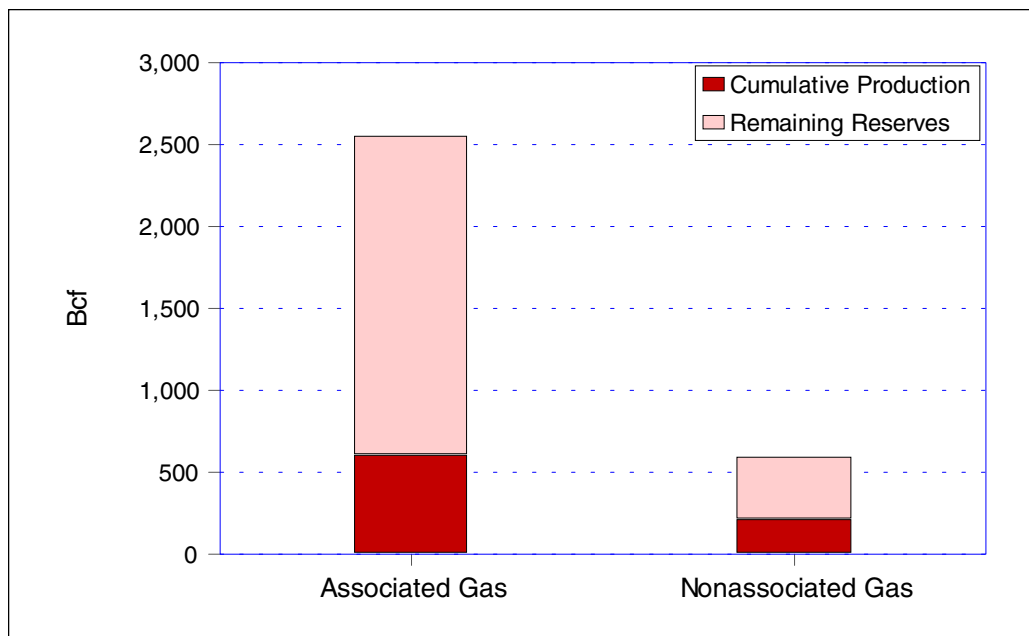


Table 4.
Production and estimated reserves of gas by type of occurrence, Pacific OCS, December 31, 1997

Type of Occurrence	Original Recoverable Reserves (Bcf)	Cumulative Production (Bcf)	1997 Annual Net Production (Bcf)	Remaining Reserves (Bcf)
Associated	2,547	604	50	1,943
Nonassociated	594	215	4	379
Total	3,141	819	54	2,322

Table 5.
Estimated reserves of oil and gas by reservoir age group, Pacific OCS, December 31, 1997.

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	516	556	113	119
Monterey	Monterey	2,018	1,907	1,589	1,600
Pre-Monterey	Point Sal, Vaqueros, Topanga, Hueneme, Sespe/Alegria, Gaviota, Matilija, Sacate, Juncal (Camino Cielo), Jalama	136	677	99	603

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

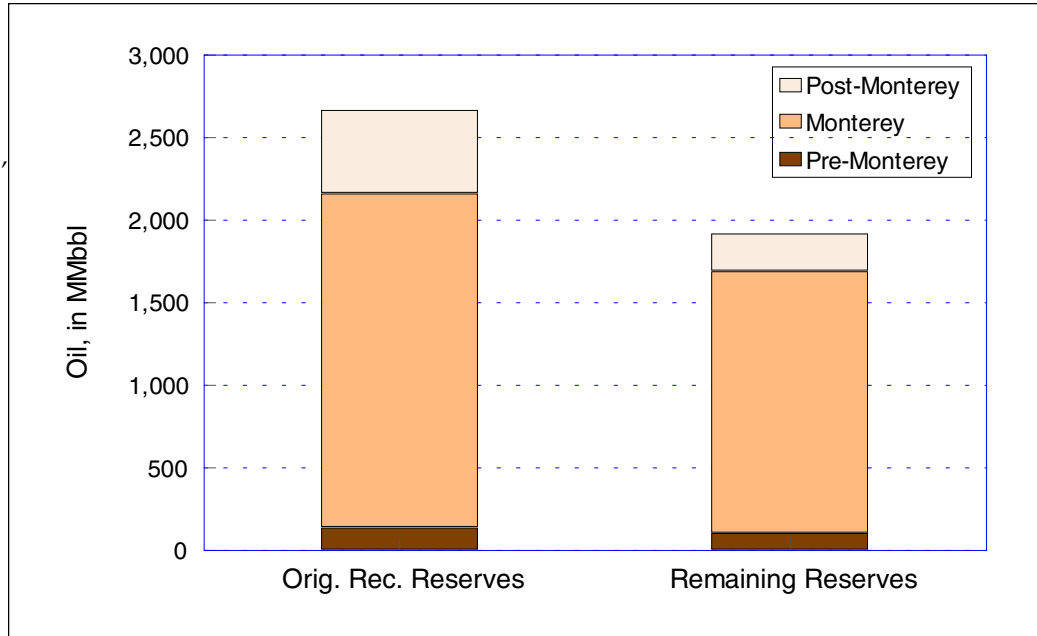


Figure 10.
 Estimated original recoverable and remaining gas reserves by reservoir age group, Pacific OCS.

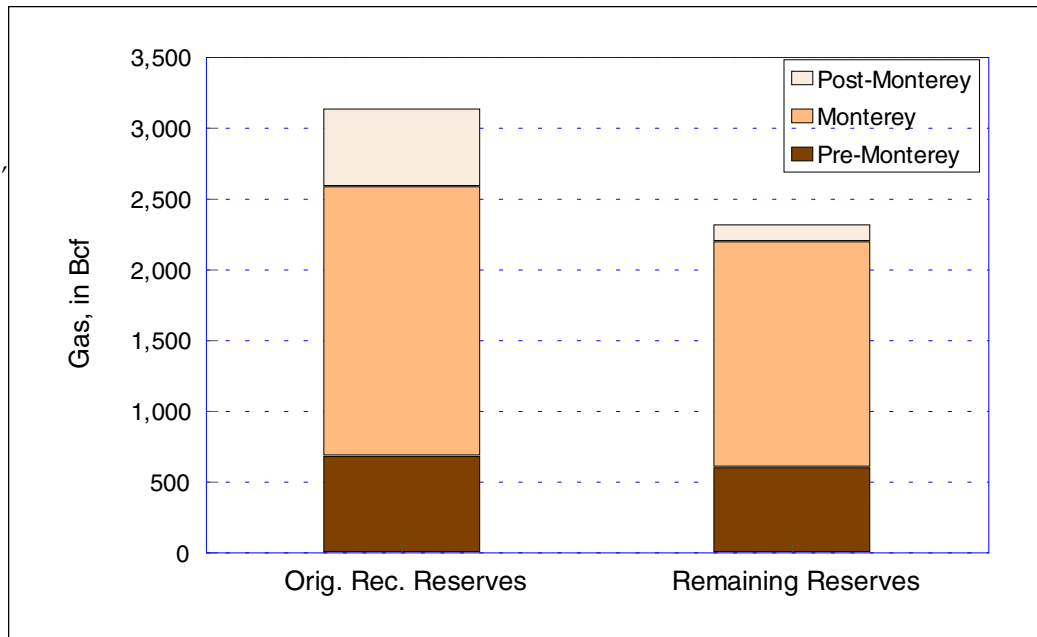


Table 6.
Gas and water
injection volumes
and rates, 1997.

Field	Gas Injection Volume (Mcf)	Average Gas Injection Rate (Mcfpd)	Water Injection Volume (bbl)	Average Water Injection Rate (bpd)
Beta	0	0	7,862,579	21,541
Carpinteria	4,568	13	0	0
Dos Cuadras	0	0	11,247,945	30,816
Hondo	14,847,445	40,678	0	0
Pescado	17,839,533	48,875	0	0
Pt. Pedernales	140,895	386	0	0
Santa Clara	0	0	1,566,017	4,290
Sockeye	0	0	2,072,664	5,679

shore, Santa Clara, Sockeye, and Beta (fig. 4, fields 6, 19, 22, 28, 30, 32, 33, and 37). Recovery beyond primary production is occurring or can be anticipated. Four fields— Point Pedernales, Pescado, Hondo, and Carpinteria Offshore (fig. 4, fields 6, 19, 22, and 30)— are undergoing gas injection for reservoir pressure maintenance or for relief of high pressure gas in emergency situations. More than 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

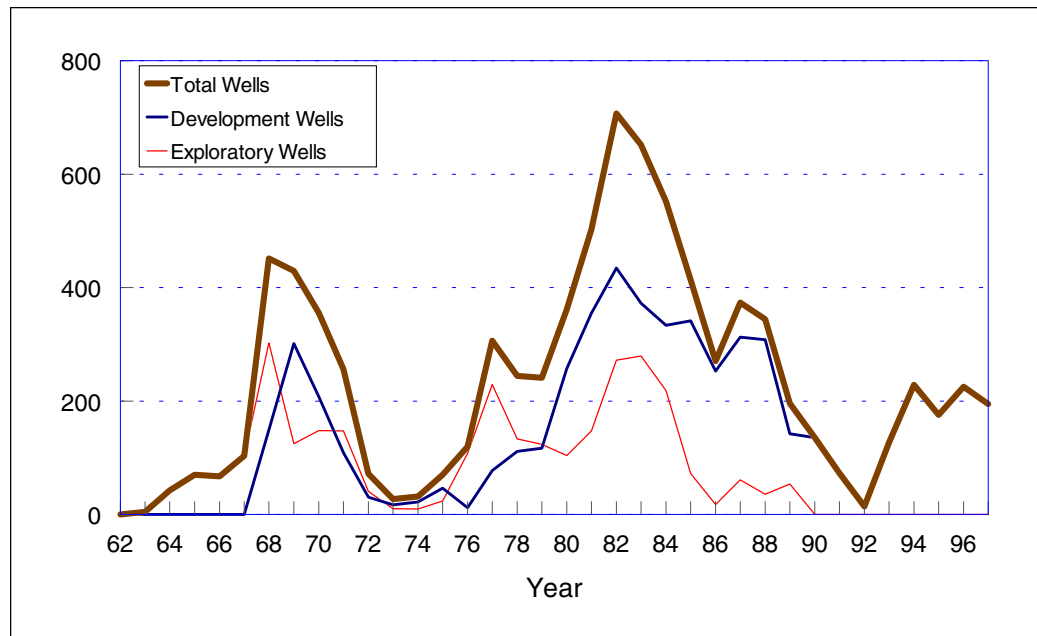
There have been 329 exploratory wells and 848 development wells drilled in the POCS as of December 31, 1997. For the eighth consecutive year, no exploratory wells were drilled in the Pacific OCS. Twentynine development wells and redrills were drilled during 1997, in seven fields. Total footage drilled in these wells approached 195,000 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 1997, to approximately 55 MMbbl of oil. Over four-fifths 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. Hondo, Pescado, and Point Arguello Fields together accounted for over three-fourths of the region's oil production, and these three fields produced almost one-tenth of the national OCS total.

Net gas production from the 11 producing fields increased slightly during 1997 to approximately 54 Bcf. 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 869 MMbbl of oil and 819 Bcf of gas in 1997. About one-half of the oil and gas production in the Pacific OCS to date has been from Post-Monterey aged reservoirs. 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 1997, 11 of the 37 fields in the Pacific OCS produced oil and gas. Sales volumes of oil and gas produced from these fields totaled 54.56 MMbbl and 33.59 Bcf, respectively. The weighted average sales prices of oil and natural gas during 1997 were \$13.33 per barrel and \$2.51 per thousand cubic feet, respectively.

Total sales of crude oil from Pacific OCS oil fields during 1997 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 1997 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-eighth of all Pacific OCS natural gas sold. Hondo Field produces more natural gas than any other single field in the region. Hondo, Sockeye, and Pitas Point Fields account for almost three-quarters 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, 1997.

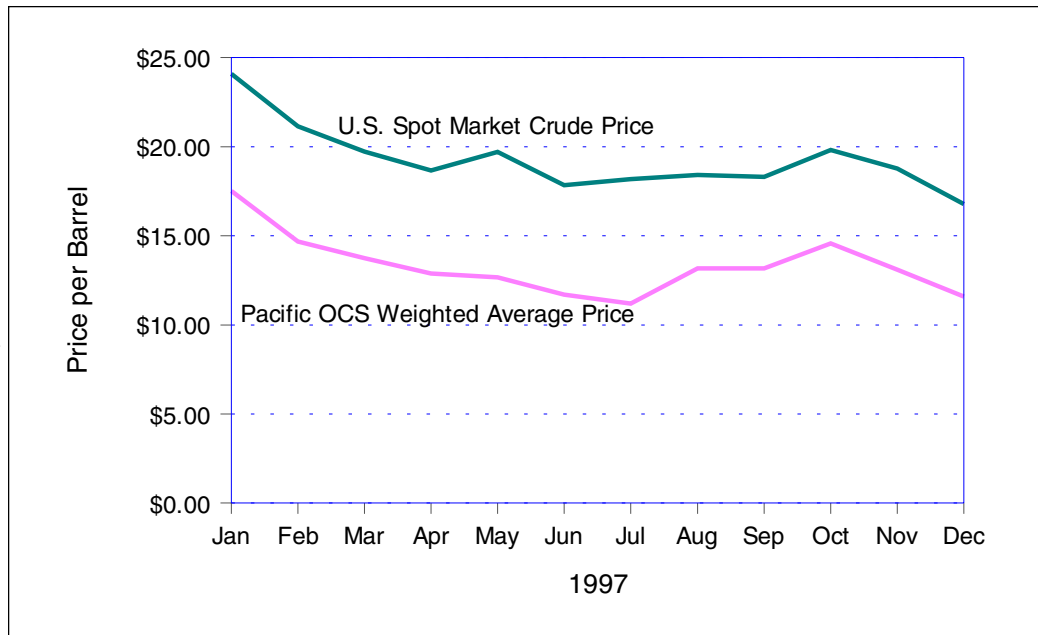
Field	Oil Sales Volume (MMbbl)	Percent of Total Sales
Pescado	17.03	31.21
Hondo	14.09	25.82
Point Arguello	10.27	18.82
Beta	3.04	5.57
Point Pedernales	3.00	5.50
Dos Cuadras	2.61	4.78
Sockeye	2.27	4.17
Santa Clara	1.18	2.17
Carpinteria Offshore	0.79	1.45
Hueneme	0.28	0.51
Total	54.56	100.00

Table 8.
Natural gas sales
volumes, Pacific
OCS, 1997.

Field	Natural Gas Sales Volume (Bcf)	Percent of Total Sales
Hondo	15.63	46.53
Sockeye	4.87	14.50
Pitas Point	4.24	12.62
Point Arguello	2.81	8.37
Dos Cuadras	2.06	6.13
Pescado	1.38	4.11
Point Pedernales	0.94	2.80
Santa Clara	0.81	2.41
Carpinteria Offshore	0.43	1.28
Hueneme	0.27	0.80
Beta	0.15	0.45
Total	33.59	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 1998.*



Conclusions

As of December 31, 1997, the total original recoverable reserves in 37 fields in the Pacific OCS, offshore California, are estimated to be 2,670 MMbbl of oil and 3,141 Bcf of gas. The remaining proved reserves in 12 oil and gas fields are estimated to be 486 MMbbl of oil and 1,412 Bcf of gas. Unproved reserves in 25 oil and gas fields in the Pacific OCS are estimated to be 1,315 MMbbl of oil and 910 Bcf of gas. Total remaining oil reserves have increased by 560 MMbbl, and gas reserves have decreased by 58 Bcf, as compared with previously published estimates.

Oil and gas were being produced from 22 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 39 Bcf of gas. Estimated original recoverable reserves for the other 10 producing fields total 1,283 MMbbl of oil and 1,784 Bcf of gas. Estimated remaining reserves for these 10 fields are 415 MMbbl of oil and 1,166 Bcf of gas. Less than one-quarter of the remaining oil reserves and about 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 1997, when approximately 55 MMbbl of oil were produced. Net gas production increased slightly to about 54 Bcf. Over nine-tenths of the gas produced during the year was associated gas produced from oil reservoirs. Over 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 869 MMbbl of oil and 819 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.

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 37 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 recoverable oil and gas reserves. Such production rates have not caused extreme annual variations between estimated original recoverable reserves and remain-

ing 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
1997	MMS 99-0023	2670	3141

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

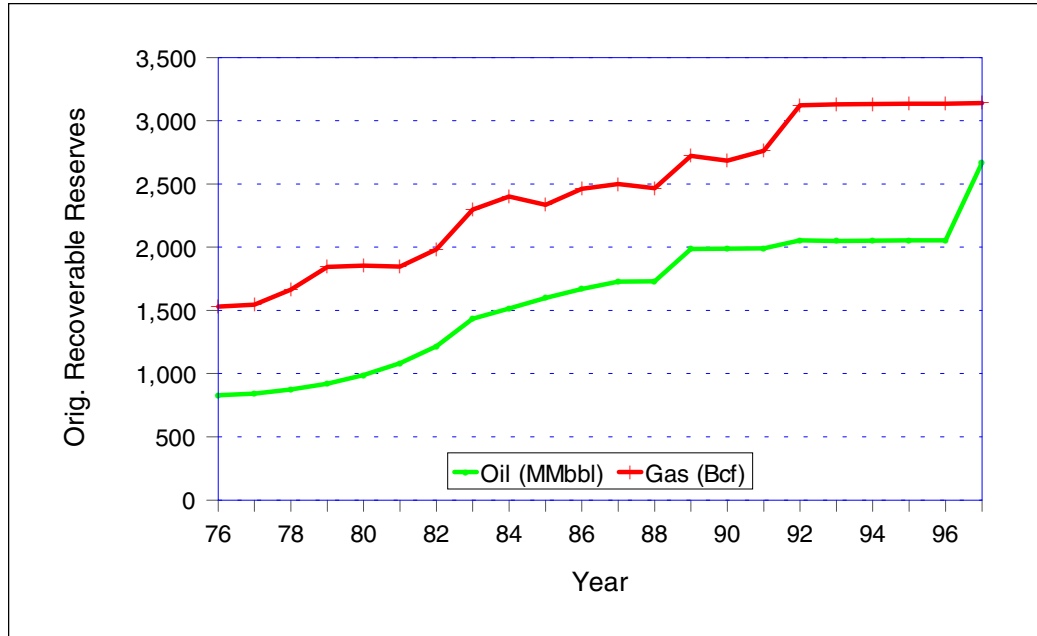
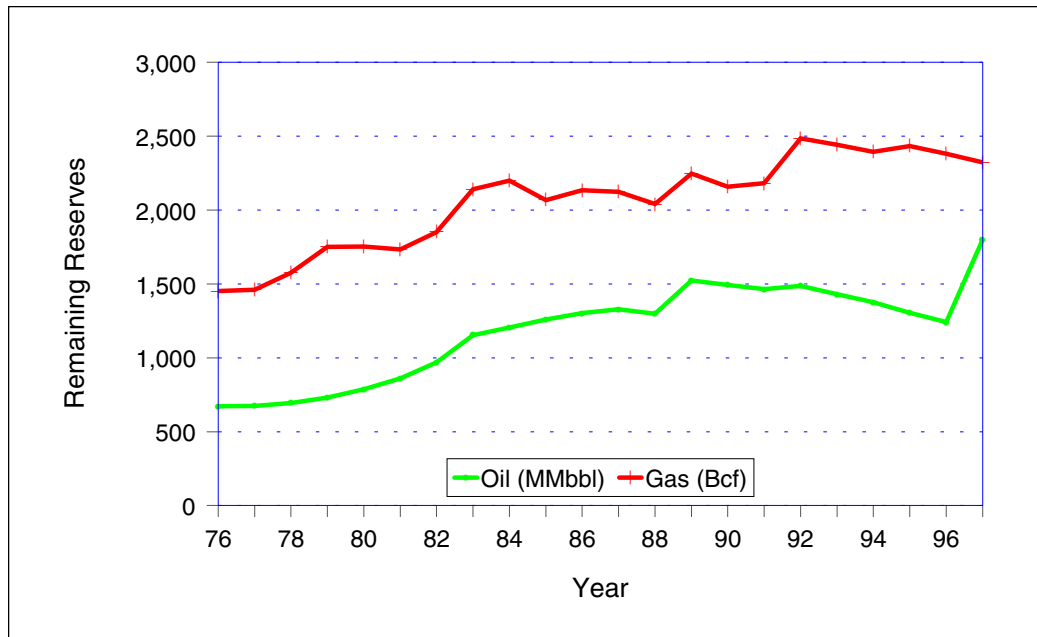


Figure A-2.
Annual estimates
of remaining
recoverable
reserves from
known fields.



Appendix B - Annual Development Activities

The pace of development activities in the Pacific OCS decreased slightly during 1997. A total of 30 new wells and redrills reached total depth by the end of 1996, and 15 new wells and 14 redrills were drilled in 1997 (tables B-1 and B-2). Additional work was also completed at each of the 11 producing fields.

Field Activities

- Beta Field* Beta Field is the only producing Pacific OCS field in the Los Angeles Basin. One new development well was drilled in the field during 1997, and three additional wells were sidetracked. There were 33 electric submersible pump changes as well. Waterflood operations continued in Leases OCS-P 0300 and 0301. Annual oil production decreased slightly to 3,038,861 bbl, while gas production increased to 1,020,854 Mcf.
- Carpinteria Offshore Field* There were no new development wells drilled at Carpinteria Offshore Field during 1997. The workover program initiated the previous year was continued in an effort to increase production rates. Oil and gas production for the year totaled 787,794 bbl and 576,106 Mcf, respectively. A major retrofit project was also begun during the year at the associated La Conchita Plant.
- Dos Cuadras Field* Nuevo Energy Company replaced Unocal as the operator of Dos Cuadras Field during 1996. Only one new well was drilled in 1997, although five additional wells had zones added to existing completions or were reperforated. Other work included attempts to control sand production (two wells) and acid jobs (two wells). Oil and gas production during 1997 amounted to approximately 2.6 MMbbl and 2.7 Bcf, respectively.
- Hondo Field* The development of Hondo Field continued in 1997 with the drilling of five new wells and two redrills. A number of other workovers were also performed. These included acid stimulation, water isolation, and perforation jobs. An additional main gas compressor was added at Platform Harmony. Annual oil and gas production from Hondo Field exceeded 16.2 MMbbl and 25.5 Bcf, respectively, during 1997.
- Hueneme Field* Nuevo Energy Company became the new operator of Hueneme Field in 1996. No new wells were drilled during 1997. Annual oil production declined to approximately 279,572 bbl, while gas production for the year dropped to 289,384 Mcf.

- Pescado Field* Pescado Field became the eleventh producing field in the Pacific OCS in December 1993. Seven new development wells and sidetracks were drilled and completed from Platform Heritage during 1997. A number of workovers were also performed, including stimulation, reperforation, and water shut-off jobs. Another main gas compressor was installed at Platform Heritage, with gas sales from the field expected to commence in late 1998. Annual oil production totaled about 14.9 MMbbl. Net gas production for the year exceeded 5.8 Bcf.
- 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 1997. Gas production for 1997 exceeded 4.4 BCF, while condensate production totaled 3,503 bbl.
- Point Arguello Field* The field was unitized in October 1996, with Chevron designated as the unit operator for all three platforms. Three redrills were completed in Point Arguello Field during 1997. Perforation jobs were performed in 44 wells, 14 wells received acid stimulations, and 14 wells were plugged back. Production logs were run in 19 wells, two frac treatments were completed, and four wells were abandoned. Annual oil and gas production from the field declined sharply to about 10.3 MMbbl and 6.0 Bcf, respectively.
- Point Pedernales Field* One new development well and one redrill were drilled in the Point Pedernales Field during 1997. The Tranquillion Ridge Unit was formed in April 1997, consisting of portions of leases OCS-P 0441 and 0444. One of the two wells drilled from Platform Irene during the year initiated production from the new unit, with average daily oil production rates exceeding 800 bopd. Production of oil from Point Pedernales Field declined to 3.1 MMbbl in 1997. Net gas production for the year also decreased to approximately 1.1 Bcf.
- Santa Clara Field* Four redrills were finished in the Santa Clara Field during 1997. All four wells were drilled from Platform Gilda. A project to abandon the development wells drilled from Platform Grace was underway, with the initial phase (plugging off perforated intervals) completed in early 1997. Annual oil and gas production from the field continued to decline, to approximately 1.2 MMbbl and 900 MMcf, respectively.
- Sockeye Field* No wells were drilled from Platform Gail in Sockeye Field during 1997. Perforations were added in three wells in the Sespe and Topanga Formations. Three producing wells and two injectors were acidized, and workovers were performed on four wells to reduce sand production. Annual oil production totaled over 2.1 MMbbl, with gas production during 1997 approaching 5.8 Bcf.

Table B-1.
Summary of development well borehole status at yearend, 1997.

Platform Name	APD	ACT	DSI	COM	PA	ST	TA	Total
A				50		15		65
B				54	1	20		75
C				35				35
Edith				18		1	2	21
Ellen				61	5	8		74
Eureka				50	1	3		54
Gail				21	1			22
Gilda				61	3	14	2	80
Gina				12	2			14
Grace				1	2	7	25	35
Habitat				18	1		2	21
Harmony				22	2	2	1	27
Harvest				14	2	2	1	19
Henry				23	1	1		25
Heritage				28		7	1	36
Hermosa				10	2	6	1	19
Hidalgo				10	1			11
Hillhouse				48	4			52
Hogan				34	4	12		50
Hondo				26	1	13		40
Houchin				32	3	7	1	43
Irene				23	2	4	1	30
Total				651	38	122	37	848

Table B-2.
Summary of
development well
completion status
at yearend, 1997.

Platform Name	POW	GLO	PGW	OSI	GSI	GIW	WIW	WDW	WSW	Total
A	32			14			7			53
B	32			17			8			57
C	25			3			12			40
Edith	16			2						18
Ellen	26			9	1		21	1	3	61
Eureka	32		1	1			16			50
Gail	1	17	2	6			1	1		28
Gilda	33			11	3		17			64
Gina	4			3			5			12
Grace								1		1
Habitat			14		6					20
Harmony		21		2		2				25
Harvest	2	10		5		1				18
Henry	21			2						23
Heritage	2	20		1		4		1		28
Hermosa	4	6		2						12
Hidalgo		9		1						10
Hillhouse	24			25						49
Hogan	11			20				3		34
Hondo	5	16		5		2		1		29
Houchin	16			18						34
Irene	3	8		11		1				23
Total	289	107	17	158	10	10	87	8	3	689

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, 1997, 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 869 MMbbl of oil and 819 Bcf of gas have been produced from 11 fields. Cumulative production equals about one-third 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 64 MMbbl and to about 55 MMbbl by yearend 1997 (table C-1, and figs. C-1 and C-2). This amount, produced from 22 platforms in 11 fields, represents over one-tenth of the Nation's OCS oil production for the year.

Net gas production from the Pacific OCS had also increased slightly by yearend, to approximately 54 Bcf. Gas production from Pitas Point Field, the only producing gas field in the region, continued to decline during 1997, as did gas production from Point Arguello and Sockeye Fields. Hondo and Pescado Fields produced significantly more gas during 1997. Production from these five fields exceeded 47 Bcf, accounting for almost nine-tenths of the gas produced in the Pacific OCS.

During 1997, 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 868 MMbbl of oil and 819 Bcf of gas in 1997 (table C-1 and fig. C-4). The amount of oil produced to date is almost two-thirds of the proved original recoverable reserves and one-third 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

exceeds one-third of the proved original recoverable reserves and one-fourth of the total original recoverable reserves.

Dos Cuadras Field has produced more oil than any other field in the Pacific OCS. Over one-fourth of the region's cumulative oil production can be attributed to Dos Cuadras Field. Almost 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 Hondo Field exceeds that from any other field in the region. Pitas Point Field, the only producing gas field in the Pacific OCS, currently ranks second in terms of cumulative gas production. The combined total gas production from the two fields amounts to almost 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.

Almost one-half of the oil and two-fifths of the 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-half of the gas produced by December 31, 1997, has been obtained from reservoirs in the Monterey Formation.

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. Unless noted otherwise, all tables and figures in this appendix reflect this adjustment.

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
1997	54,506,896	868,767,396	54,160,238	818,628,750

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

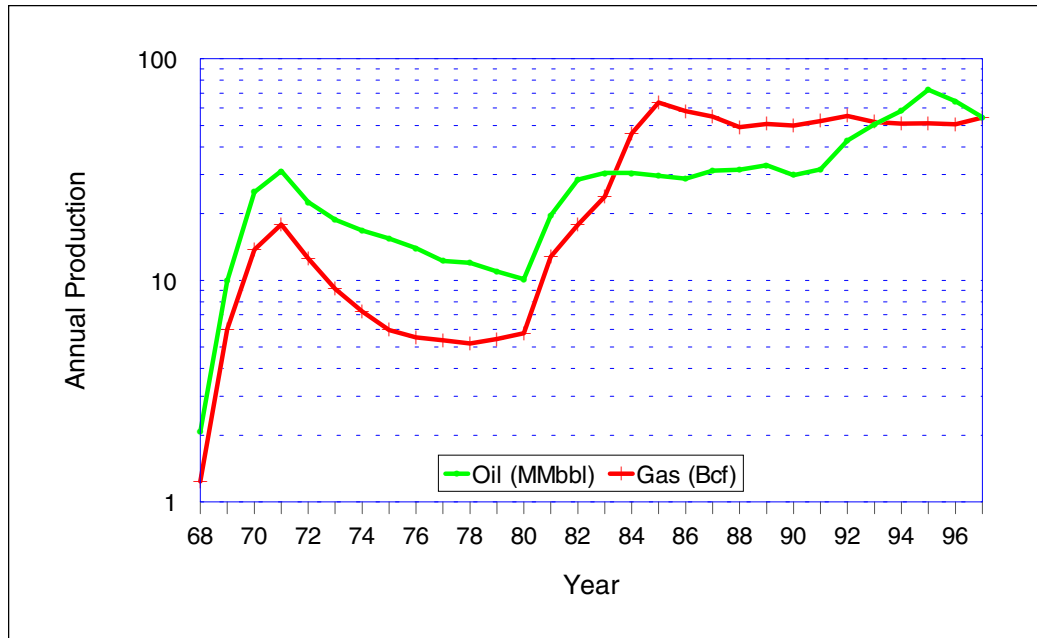


Figure C-2.
Average daily
production for the
Pacific OCS.

Gas figures in this
chart reflect gross
gas production.

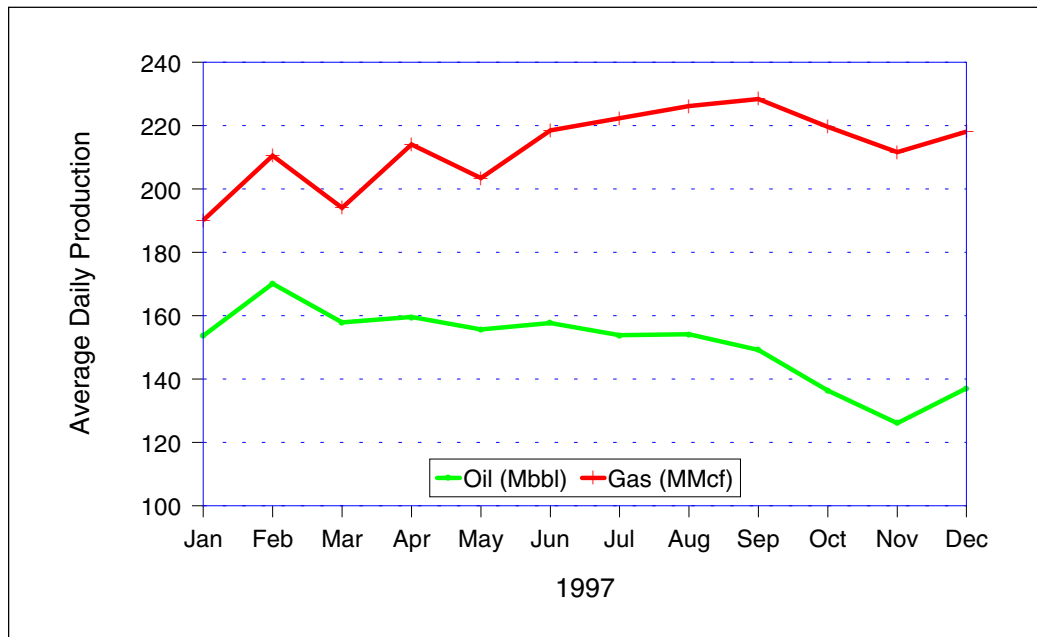


Figure C-3.
Annual production of oil and gas by reservoir age group, Pacific OCS, December 31, 1997.

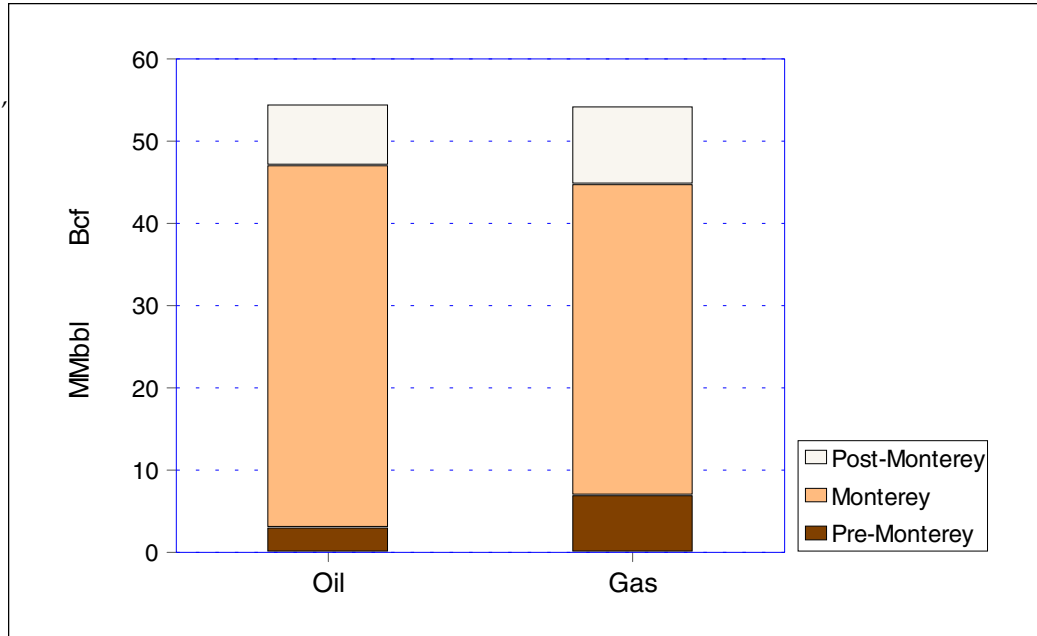


Figure C-4.
Cumulative production for the Pacific OCS.

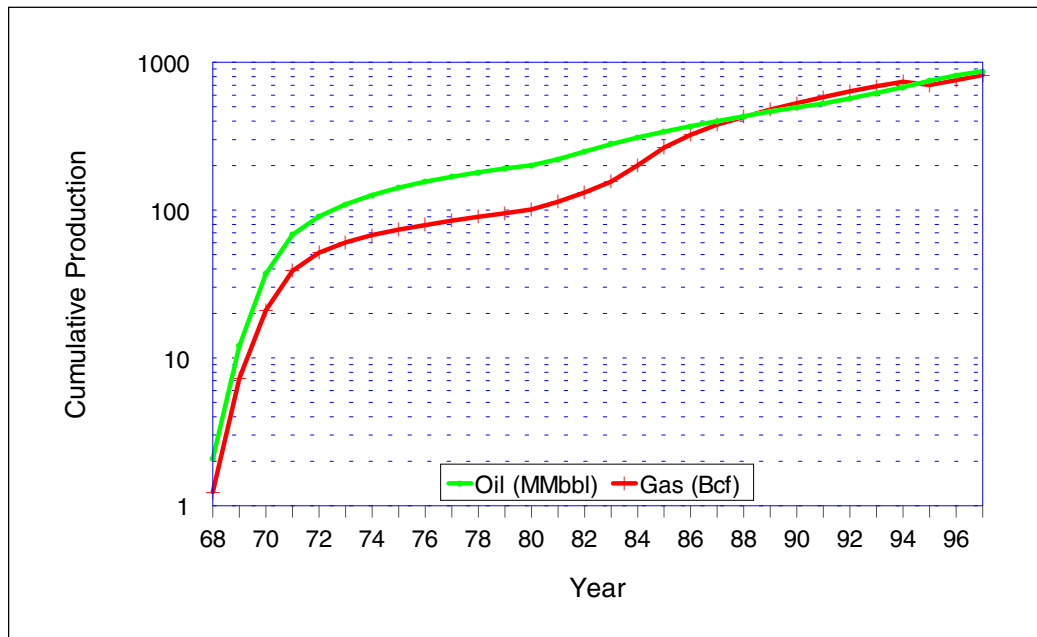
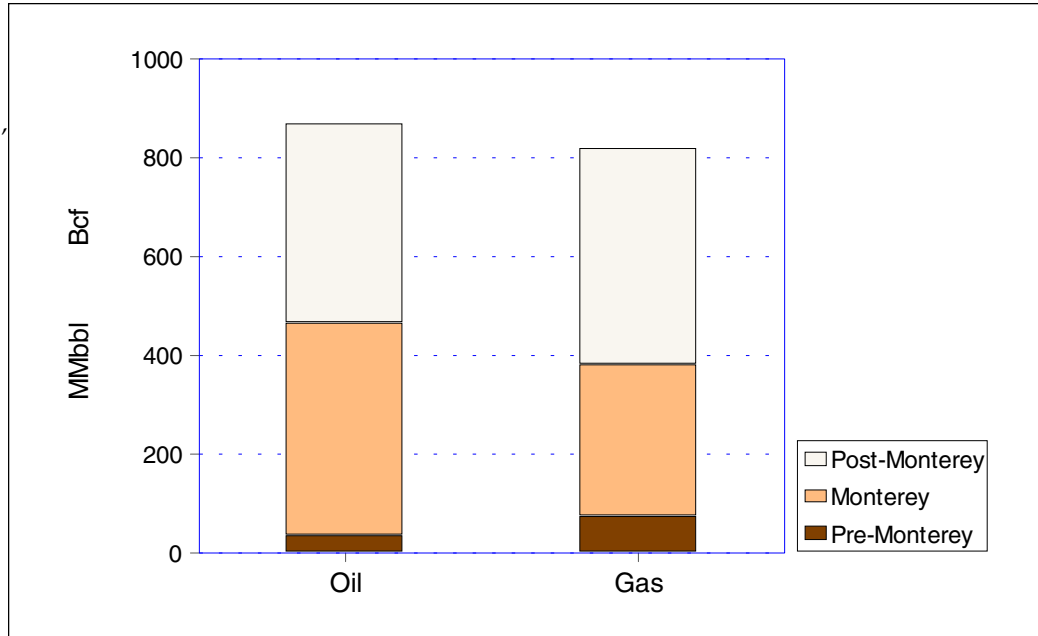


Figure C-5.
Cumulative
production of oil
and gas by
reservoir age group,
Pacific OCS,
December 31, 1997.





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.