OIL AND GAS OPERATIONS OFFSHORE CALIFORNIA: STATUS, RISKS, AND SAFETY

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SUMMARY

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Offshore oil operations in California are conducted from 23 platforms in Federal waters (> 5 km from shore) and 10 platforms and related facilities in State waters (< 5 km), distributed over an area of about 20,000 km^2 along the southern coast of the state. In 2000, approximately 36 million barrels (bbl) of oil were produced from Federal waters, all of which was transmitted to shore by pipeline. In comparison, approximately 260 million bbl of crude oil and distillates (e.g., gasoline) are transported by tanker along the California coast each year. The largest oil spill from offshore oil operations in California was the 1969 80,000-bbl Santa Barbara spill, which resulted in the loss of thousands of birds. This spill was a pivotal event for both the environmental movement in the U.S.A. and for offshore oil safety. After 1969, the rules and regulations governing offshore oil were rewritten and new rules were developed. Since 1969, only one spill from oil and gas operations offshore California has resulted in documented seabird mortality, the 163-bbl Platform Irene pipeline spill off Point Arguello in 1997, which resulted in the loss of more than 700 birds. Only a few small spills have occurred since 1969. However, based on the amount of offshore oil expected to be produced in California over the next 28 years and the number of spills that have occurred in the past, the risk of a spill of 1,000 bbl or greater occurring during that period is estimated at 41.2 percent for Federal operations and 8.4 percent for State operations (reflecting the much smaller volume of oil produced and transported in State waters).

Keywords: California, seabirds, offshore oil and gas, oil-spill risk

INTRODUCTION

The risk of accidental oil spills and the potential for subsequent impacts on biological resources such as seabirds have been a concern since oil and gas development began offshore California. This paper provides an overview of oil and gas activities offshore California in relation to area seabird populations. It discusses the current status of offshore oil and gas operations, the volumes of oil and gas produced offshore California, and the risk of an oil spill occurring from offshore oil and gas operations. It also briefly describes the safety measures and inspection programs developed to help reduce the risk of an offshore oil spill.

California was the site of the earliest attempts at offshore oil production in 1896, when oil derricks were placed on piers along the coast at Summerland near Santa Barbara. For the next several decades, development in the shallow nearshore zone continued to be limited to wells drilled from piers or slant-drilled from inland sites. These activities were unregulated until 1921, when regulation by the State began (Lima 1994). The first offshore oil platform was not installed in California until 1956, when Platform Hazel was constructed in State waters east of Santa Barbara (Molotch & Freudenburg 1996). Leasing in Federal waters off California began in 1966, and the first Federal platform, Platform Hogan, was installed in 1967 (Lima 1994, Molotch & Freudenburg 1996).

OIL AND GAS PRODUCTION OFFSHORE CALIFORNIA

Currently, there are 27 offshore oil platforms and 6 artificial oil and gas islands distributed over an area of about 20,000 km^2 along the coast of California, all off the southern and central California coastline (Fig. 1, 2). In comparison, there are approximately 4,000 offshore platforms in the Gulf of Mexico. The platforms and artificial islands off California each have multiple wells, the number of which varies from less than 10 to more than 50. The amount of oil produced by each structure varies from a few hundred to more than 20,000 bbl per day.

Offshore platforms are under the jurisdiction of either the Federal government or the State of California, depending on distance from shore. Twenty-three (23) of the 27 platforms are in Federal waters, which are defined as being more than 3 miles (5 km) from shore. Platforms in Federal waters, termed the outer continental shelf (OCS), are regulated by the U.S. Department of the Interior's Minerals Management Service (MMS). The remaining 4 platforms and 6 artificial oil and gas islands are in State waters less than 3 miles from shore; these facilities are regulated by the California State Lands Commission and the California Department of Oil, Gas, and Geothermal Resources.

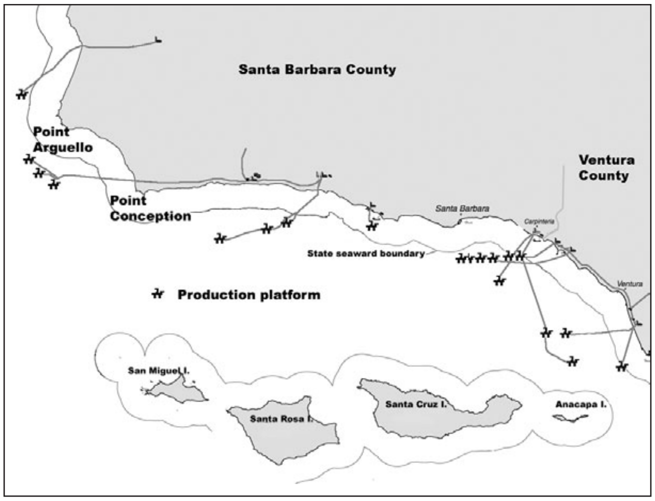

Fig. 1. Map of southern California, showing the position of offshore oil installations and pipelines.

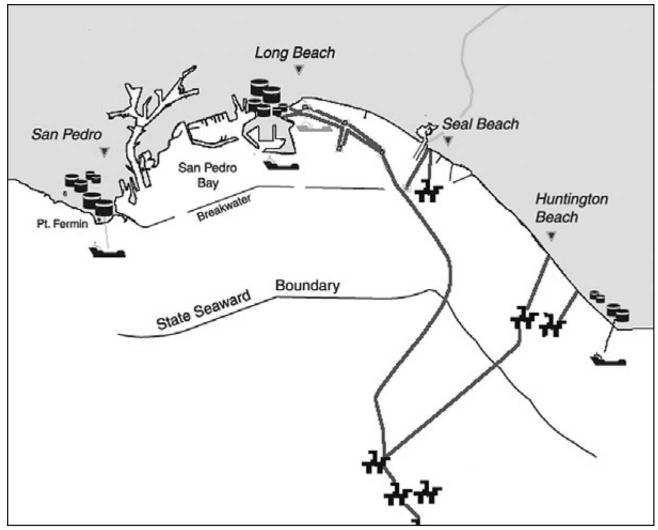

Fig. 2. Map of the Long Beach area, showing oil installations and pipelines.

TABLE 1
Crude, diesel, or other hydrocarbon spills recorded off southern California in the MMS Pacific OCS Region, from 1969 through 1999 (volumes in barrels).

	≤ 1 bbl		> 1 bbl < 50 bbl		≥ 50 bbl		Total	
Year	**No.**	**Volume**	**No.**	**Volume**	**No.**	**Volume**	**No.**	**Volume**
1969	0		0		2	80,900.0	2	80,900.0
1970	0		0		0		0	
1971	0		00		0		0	
1972	0		0		0		0	
1973	0		0		0		0	
1974	0		0		0		0	
1975	1	0.1	0		0		1	0.1
1976	3	1.1	1	2.0	0		4	3.1
1977	11	2.2	1	4.0	0		12	6.2
1978	4	1.2	0		0		4	1.2
1979	5	1.7	1	2.0	0		6	3.7
1980	11	4.9	2	7.0	0		13	11.9
1981	21	6.0	10	75.0	0		31	81.0
1982	24	3.2	1	3.0	0		25	6.2
1983	56	7.7	3	6.0	0		59	13.7
1984	65	4.7	3	36.0	0		68	40.7
1985	55	9.3	3	9.0	0		58	18.3
1986	39	5.5	3	12.0	0		42	17.5
1987	67	7.5	2	11.0	0		69	18.5
1988	47	3.7	1	2.0	0		48	5.7
1989	69	4.1	3	8.0	0		72	12.1
1990	43	3.6	0		1	100.0	44	103.6
1991	51	5.8	1	10.0	1	50.0	53	65.8
1992	39	1.2	0		0		39	1.2
1993	32	0.7	0		0		32	0.7
1994	18	0.4	2	33.0	1	50.0	21	83.4
1995	25	0.9	1	1.4	0		26	2.3
1996	39	0.9	1	5.0	1	150.0	41	155.9
1997	20	2.5	0		1	163.0	21	165.5
1998	29	1.0	0		0		29	1.0
1999	22	0.5	1	10.0	0		23	10.5
Total	**796**	**80.4**	**40**	**236.4**	**7**	**81,413.0**	**843**	**81,729.8**

All oil and gas produced offshore California is transported to shore by pipeline, although oil produced from State Platform Holly is piped ashore and then barged to refineries in the Los Angeles area from the Ellwood facility near Santa Barbara. There is a total of about 229 km of oil pipeline associated with oil development offshore California.

In 2000, the 23 Federal platforms produced about 95,000 bbl of oil per day, or a total of roughly 36 million bbl for the year (a barrel of oil is equal to 160 l) (MMS, unpubl. data). An additional 18 million bbl were produced in State waters in that year (California Department of Conservation 2001). In comparison, approximately 260 million bbl of oil are transported by tankers to ports in California annually (DNA Associates 1993, Minerals Management Service 2001).

Oil fields have a finite life, and all of these platforms will eventually be removed. Four platforms in State waters were removed in 1996, and MMS estimates that all of the platforms in Federal waters could be removed by 2025. There has been no new leasing in California Federal and State waters since 1984, and it is unlikely that any leasing will occur in the future. There also have been various moratoria on new leasing in Federal waters, some of which date back to the early 1980s. The Pacific OCS, which includes Federal waters off California, Oregon, and Washington, currently is under a leasing moratorium that extends through June 30, 2012. This moratorium does not apply to 36 undeveloped leases, which originally were leased between 1968 and 1984 and have been controversial; recent court decisions have made their future uncertain.

OIL SPILL RISK

A major environmental concern with offshore oil and gas activities is the potential for oil spills and the resulting effects on biological resources, such as seabirds. One way to estimate the size of a future oil spill is to consider the sizes of past spills. The largest oil spill in the Pacific OCS Region occurred in 1969, when a well blowout on Platform A off Santa Barbara spilled an estimated 80,000 bbl into the Santa Barbara Channel (Table 1) (Van Horn *et al*. 1988). As discussed below under Oil Spill Prevention and Response, a number of technological improvements and changes to rules and regulations covering offshore operations have been made since that time (Bornholdt & Lear 1997). No spill of this magnitude has occurred on the U.S. OCS since 1969, and these measures make a reoccurrence highly unlikely.

Table 1 lists hydrocarbon spills that occurred in the Pacific OCS Region off southern California from 1969 through 1999. During that period, 843 oil spills were recorded. Obviously, the total volume of oil spilled in the Region is dominated by the Santa Barbara spill—since 1969, these spills have ranged in size from less than 1 bbl to 163 bbl, for a total of approximately 830 bbl. For comparison, natural oil seeps at Coal Oil Point in the Santa Barbara Channel are estimated to discharge approximately 100-170 bbl of oil per day (Hornafius *et al*. 1999).

In the course of normal, day-to-day platform operations, occasional accidental discharges of hydrocarbons may occur. Such accidents are typically limited to discharges of less than 1 bbl of crude oil. As shown in Table 1, 836 spills of less than 50 bbl (99 percent of the total spills) occurred on the Pacific OCS between 1969 and 1999, resulting in the discharge of about 320 bbl of oil into the ocean.

Larger oil spills may occur from loss of well control (if wells are free flowing), pipeline breaks, operational errors, or vessel-platform collisions. Only 7 of the 47 spills of greater than 1 bbl measured 50 bbl or more in volume (Table 1). The largest of these was the 163-bbl Platform Irene pipeline spill in September 1997.

It is possible to estimate the likely size of a future spill on the Pacific OCS. The MMS's U.S. Oil Spill Database (C. Anderson, MMS, unpublished data) includes data on Pacific and Gulf of Mexico OCS spills of greater than 1.5 bbl recorded between 1971 and 1999. The database contains platform and pipeline spills, but no barge or tanker spills. Of the 2,125 total spills in the database, 106 were in the range of 50-999 bbl. The mean volume of these spills was 158.6 bbl, and 75 percent (79 spills) were of less than 200 bbl. More than 95 percent (101 spills) were of less than 500 bbl. Given these data and the history of spills in the Pacific Region over the last 30 years, the volume of a future spill on the Pacific OCS would most likely be less than 200 bbl, and almost certainly less than 500 bbl.

Another method for estimating future spill size is to look at a worst-case scenario. Federal regulations concerning oil spill response plans for OCS facilities require operators to calculate worst-case discharge volumes using specified criteria (U.S. Code of Federal Regulations: 30 CFR Part 254.47) to insure that an operator has the capacity to respond to the largest conceivable spills. These include 1) the maximum capacity of all oil storage tanks and flow lines on the facility, 2) the volume of oil calculated to leak from a break in any pipelines connected to the facility, and 3) the daily volume that could be spilled from an uncontrolled release (blowout) of the highest capacity well associated with the facility.

A catastrophic event would be required to empty all storage tanks and flow lines on a production platform. Similarly, with the implementation of modern blowout prevention equipment, operating procedures, and the MMS inspection program (see below), uncontrolled releases have become rare. In the ten-year period from 1992 through 2001, only three instances of loss of well control have occurred in the Pacific Region; only one of these resulted in any oil in the water (less than one gallon; MMS, 2002). On the Gulf of Mexico OCS, with much greater levels of activities, no blowout since 1970 has spilled more than about 60 bbl of oil (C. Anderson, MMS, unpubl. data).

Based on this worst-case analysis, the largest spill likely to occur from offshore California would be about 2,000 bbl (roughly the volume of oil in the longest section of pipeline). Thus, if an oil spill were to occur, it is likely that it would measure about 50 to 2,000 bbl in volume.

In addition to the probable size of a future spill, another consideration is the likelihood of a spill occurring from oil and gas operations offshore California. In general terms, oil spill risks are estimated from the amount of oil produced and the number of oil spills that have occurred in the past (Anderson & LaBelle 1994). Recently, MMS has calculated the risk of a spill of greater than 1,000 bbl occurring off California from existing and projected offshore oil operations (Minerals Management Service 2001). Based on these calculations, it was estimated that there is a 41.2-percent chance of a spill occurring from Federal operations in the next 28 years, and an 8.4-percent chance of one occurring from State operations (as discussed above, the latter reflects the much smaller volume of oil produced and transported in State waters). Although oil and gas production levels are expected to decline, these estimates assume that production would continue at current levels for this entire period. The likelihood of a smaller spill occurring is greater; the risk of a 50- to 999-bbl spill is about 95 percent for Federal operations and 39 percent for State operations. For the same period, it was estimated that there is a 99-percent chance of a spill of 1,000 bbl or greater occurring as a result of the tankering of Alaskan and foreign crude oil through the region.

RISKS TO SEABIRDS

Applying information on estimated spill size and spill probability to potential impacts on seabirds is difficult because of the many factors involved. Impacts will depend on the type, rate, and volume of oil spilled and the weather and oceanographic conditions at the time of the spill. These factors would determine the quantity of oil that is dispersed into the water column; the degree of weathering, evaporation, and dispersion of the oil before it contacts a shoreline; the actual amount, concentration, and composition of the oil at the time of shoreline or habitat contact; and the toxicity of the oil.

To improve its ability to estimate potential oil spill impacts, MMS has funded or cooperated in a number of studies since the 1970s on the distribution and abundance of California seabirds, both at sea and on the colonies (e.g., Briggs *et al*. 1981, 1983, 1987a, 1987b, Hunt *et al*. 1981, Carter *et al*. 1992, Pierson *et al*. 2000). The waters off southern and central California provide important habitats for seabirds known to be especially sensitive to oil spill impacts. This is particularly true of nearshore areas, which harbor numerous diving species, such as grebes, loons, cormorants, and scoters. These species are especially abundant along the protected mainland shore of the Santa Barbara Channel, where Western Grebes (here, both Western Grebes *Aechmophorus occidentalis* and Clark's Grebes *A. clarkii* will be referred to as Western Grebes) predominate seasonally with winter densities of up to 400 birds per km^2 (Pierson *et al*. 2000).

North of Point Conception along the central California coast, birds at particular risk to the effects of oil spills include alcids such as the Common Murre *Uria aalge*. Cassin's Auklets *Ptychoramphus aleuticus*, which breed in large numbers on San Miguel Island, are seasonally abundant in this area, as well as in open waters in the western Santa Barbara Channel (Briggs *et al*. 1981, 1983, 1987b). The 1969 Santa Barbara oil spill was an extremely large and very serious spill. It was estimated 4 months after the spill that 3,686 birds had been killed (Straughan 1971). This was an underestimate, because it did not include birds that had died at sea and whose carcasses had not been recovered or had not reached shore. Straughan (1971) reported that most of the dead birds were grebes and loons, followed by waterfowl (presumably largely scoters), cormorants, and pelicans. Western Grebes accounted for nearly 41 percent (176) of a sample of 432 birds whose species were known. In addition, gulls, alcids (mostly Common Murres), shorebirds, and herons are known to have been oiled and died (Drinkwater *et al*. 1971, Straughan 1971).

The much smaller Platform Irene pipeline spill in 1997 occurred north of the Santa Barbara Channel, along the coast near Point Arguello. This spill is estimated to have killed more than 700 birds (California Department of Fish and Game 2002). Birds affected included Brown Pelicans *Pelecanus occidentalis*, Snowy Plovers *Charadrius alexandrinus*, Common Murres, Brandt's Cormorants *Phalacrocorax penicillatus*, and 18 other species.

The principal model used by MMS to determine probabilities of oil spill landfall and impacts to resources is the Oil Spill Risk Assessment (OSRA) Model (Anderson & LaBelle 1999). The OSRA Model calculates numerous trajectories from a pre-designated launch point by varying the wind over a static, seasonally averaged ocean-current field and applying the deep-ocean 3.5-percent wind rule to project the assumed movement of oil over the surface layer of the water. Shoreline segments are partitioned into their USGS Quadrangle maps, and probabilities of oil-spill landfall for each shoreline segment are calculated. The probabilities of oil spill intrusion into defined offshore areas are also generated.

In order to estimate the location and size of areas that might be contacted by proposal-generated oil spills, MMS has generated conditional oil-spill probability data. Conditional oil-spill probabilities are independent of both the accident spill rates and resource estimates; they are based solely on OSRA Model simulation trajectories and assume that a spill has occurred. The OSRA Model calculates probabilities of contact to shoreline segments and offshore blocks for spills from each identified launch point over 3-, 10-, and 30-day periods.

Another method, surface drifter analysis, has been used in MMS-funded studies to provide indications of water movement using actual Lagrangian current observations. The drifter analysis does not depend on a calculation scheme using seasonally averaged currents, modeled winds, and wind estimators, as does the OSRA Model.

Surface drifter analysis provides a measure of the likelihood that a drifter, and therefore possibly a surface-floating pollutant such as oil, would be transported in a certain direction. Because of the small number of drifter observations, the calculated percentage (probability) that a drifter will move in a certain direction, or make contact with a shoreline, should be viewed cautiously. Also, it should be kept in mind that free-floating surface drifters are designed to follow the flow of the upper 1-meter of the water column, not necessarily oil. Although drifter analysis results do not always agree with OSRA Model calculations, both analyses provide important insights that help present a more complete picture of what may occur when oil is spilled.

OIL SPILL PREVENTION AND RESPONSE

The 1969 Santa Barbara oil spill is considered by many to be the pivotal event in the development of the modern environmental movement. However, the 1969 spill was also a pivotal event in the history of offshore oil safety. Since 1969, a number of preventive measures have been initiated, including stringent regulations covering OCS operational and environmental safety, a rigorous MMS inspection program in the Pacific OCS Region, continuous evaluation and improvement in OCS facilities' oil spill response, and the development of a highly organized oil-spill response structure (Bornholdt and Lear, 1997).

Platform Inspections and Drills

The MMS oversees and regulates the exploration and production of oil and gas on the OCS. In the Pacific OCS Region, MMS inspectors and engineers visit the offshore platforms by helicopter 365 days a year to ensure that safety, maintenance, and operational standards are being maintained and to prevent oil spills from occurring. Unannounced, partial production and drilling inspections of every offshore facility in the Region are conducted once per quarter, in addition to thorough annual inspections of each facility. Three or four times per year, the MMS also conducts intensive, multi-day inspections, known as focused facility inspections (FFIs), rotating among the offshore facilities.

In order to test offshore operators' states of readiness and response capabilities, as well as their knowledge and understanding of their individual oil-spill response plans (OSRPs), the MMS also conducts frequent, unannounced oil-spill response exercises at OCS facilities. Appropriate Federal, State, and local agencies are notified of and frequently take part in the exercises. Two types of exercises are conducted: 1) equipment-deployment exercises (EDEs), and 2) table-top exercises (TTEs).

EDEs can be minor or major. A minor EDE requires the successful deployment and operation of primary response equipment at the platform. A major EDE requires the establishment of an onshore incident command center, as well as the successful deployment and operation of primary and, to some degree, secondary response equipment. Minor EDEs are conducted at least once per year for each offshore facility. The MMS schedules one major EDE every year, rotating among the facilities.

A TTE is an exercise of an operator's spill-management team's response while simulating deployment of response equipment. An intended EDE may become a TTE, if for some reason (e.g., weather) response equipment cannot be deployed without unacceptable risk to personnel and the EDE cannot be rescheduled.

Pipeline Inspection

The Pacific OCS Region also conducts an offshore pipeline inspection program that includes several types of regular inspections. Operators are required to conduct weekly inspections by boat or aircraft of the ocean surface along the pipeline route for leakage. The records of these inspections must be submitted annually to the MMS.

External and internal inspections of all oil and gas pipelines by a third party are also required in alternating years. The external inspections, which must be conducted using ROV or side-scan sonar, are intended to identify burial and spanning conditions, protrusions, structural integrity, damage, and corrosion to the pipeline. The internal inspections involve the use of internal survey tools to identify corrosion and/or damage.

MMS regulations state that operators may be required to equip oil pipelines with a metering system to provide a continuous volumetric comparison between the input to the line at the structure(s) and the deliveries onshore. Such a system must include an alarm system and be sufficiently sensitive to detect variations between input and discharge volumes. Alternately, an operator may, with approval from the MMS, install a system capable of detecting leaks in the pipeline. The majority of the oil pipelines in the Pacific OCS Region have continuous volumetric comparison-type leak-detection systems. All oil pipeline leak detection systems must be installed and tested to demonstrate indicated design performance levels.

Oil Spill Response

As discussed above, MMS regulations require that each OCS facility have a comprehensive OSRP. Federal regulations (30 CFR Part 254) specify oil-spill response requirements for offshore oil and gas facilities. Operators of oil handling, storage, or transportation facilities must submit a spill-response plan to the MMS to demonstrate their ability to respond quickly and effectively whenever oil is discharged from their facility. Response plans consist of an emergency response action plan, and supporting information that includes an equipment inventory, contractual agreements with subcontractors, a worst-case discharge scenario, a dispersant use plan, an in-situ burning plan, and details on training and drills. Each response plan must be reviewed by the operator at least every 2 years and be submitted with modifications to the MMS for review and approval.

Since 1970, oil companies operating in the Santa Barbara Channel and Santa Maria Basin, where most of the offshore platforms are located, have funded Clean Seas, a non-profit oil spill response cooperative (Clean Seas, 2000). Clean Seas serves its member companies by providing an inventory of state-of-the-art oil spill response equipment, trained personnel, training, and expertise in planning and executing response techniques. Clean Seas personnel and equipment are on standby, ready to respond to an oil spill, 24 hours a day, 365 days a year.

Clean Seas' area of responsibility extends from Point Dume near Santa Monica north to approximately Cape San Martin on the Big Sur coast, and includes the northern Channel Islands. To provide spill response coverage in the area, Clean Seas maintains two large Oil Spill Response Vessels (OSRVs), and several smaller response vessels.

In conjunction with the Ventura County Commercial Fishermen's Association, Clean Seas founded the Fishermen's Oil-spill Response Team (FORT) in 1990. More than 300 area fishermen have been trained to respond to spill situations as members of FORT. FORT vessels have acted in support of Clean Seas' response efforts in drills and at a number of offshore spills, where they have deployed booms, assisted with logistics, and served as wildlife rescue platforms.

Clean Seas also is equipped and prepared to respond to oil spill threats to sensitive shoreline areas within its area of responsibility. Detailed and up-to-date information on sensitive areas and response strategies in the Clean Seas' area is provided in the Northern Sector, Los Angeles/Long Beach Area Contingency Plan, which was prepared jointly by the U.S. Coast Guard, California Office of Oil Spill Prevention and Response, and U.S. Environmental Protection Agency (U.S. Coast Guard 2000), and in the Clean Seas Regional Response Manual (Clean Seas 2000).

The area of responsibility of a second response cooperative, Clean Coastal Waters, extends from Point Dume south to the Mexican Border and includes the offshore islands and waters to the outer boundary of the Pacific OCS. To provide spill response coverage in this area of operation, Clean Coastal Waters maintains three OSRVs and equipment at strategic locations in southern California. The OSRVs are based in Long Beach harbor. Like Clean Seas, Clean Coastal Waters personnel and equipment are ready to respond to an oil spill 24 hours a day.

The Marine Spill Response Corporation (MSRC) is a nationwide spill response cooperative, established by the oil industry in the wake of the *Exxon Valdez* spill. The southwest regional facility is located in Carson, California, and spill response equipment is also maintained at several other southern California locations (MSRC, 2002). The MSRC's principal southern California OSRV is currently based in Long Beach.

All the efforts that have been made to improve safety and oil-spill prevention have produced results. As apparent in Fig. 3, the number of large oil spills (1000 bbl or greater) occurring in the U.S. from Federal platforms has declined during the past 30 years, while the amount of oil produced has increased. Over the same period, the rate of pipeline spills has remained relatively constant.

Since 1969, impacts to seabirds off southern California from oil spills occurring from offshore oil and gas operations have been minor. Although the volume of oil produced offshore California is likely to decline, offshore oil operations will continue to be a presence in southern California for the next couple of decades.

However, the threat to seabirds offshore California from other sources of oil spills, especially from shipping, will be increasing. California refineries currently receive about half of their total oil supplies by marine tankers (Minerals Management Service 2001). As demand increases and Federal offshore and in-State crude oil production declines, marine tanker deliveries are expected to increase. By 2017, an estimated 200 to 337 more tankers may be visiting these ports each year (California Energy Commission 1999). Additionally, container and general cargo vessels pose an additional risk of spills. Incidents such as the 1987 wreck of the *Pac Baroness* in the Santa Barbara Channel and older incidents, such as the 1953 wreck of the *Jacob Luckenbach* near the Farallone Islands, result in risks to seabirds, sometimes well after the event.

The threat to seabirds from oil produced offshore California will decrease over the next several decades as the oil production declines. While this will decrease, it will be important to maintain oil spill clean-up and response capabilities to protect seabirds from the continuing and growing tankering and shipping activities.

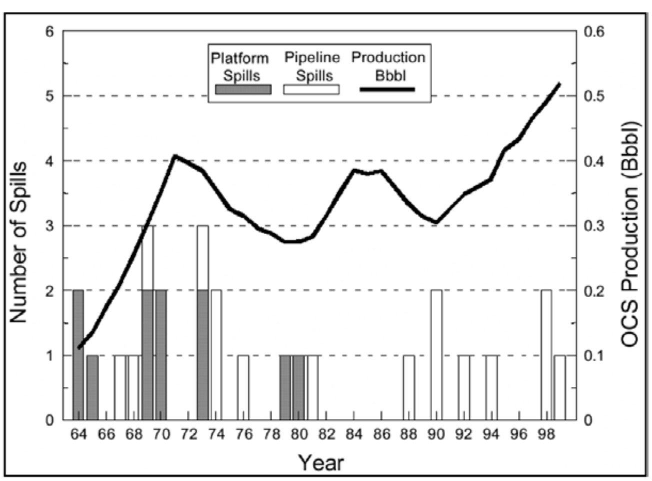

Fig. 3. Number of oil spills (> 1,000 bbl) occurring on the U.S. outer continental shelf (OCS) versus U.S. oil production, 1964-1999. Source: Anderson and Labelle (1999).

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