CHAPTER 4

A GUIDE TO ECOLOGICAL AND POLITICAL ISSUES SURROUNDING OIL PLATFORM DECOMMISSIONING IN CALIFORNIA

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Decommissioning Alternatives

Within one year of an OCS lease termination, the Minerals Management Service (MMS) requires that the lessee remove the oil platform structure to a depth of fifteen feet below the mud line, and the leased area must be cleared of obstructions (*see generally*, 30 C.F.R. Part 250, subpart Q, § 250.1700 *et seq.*). However, the MMS may waive these requirements to accommodate conversion of a platform structure to an artificial reef provided that (1) the remaining structure does not inhibit future oil or other mineral development, (2) the resulting artificial reef complies with the Army Corps of Engineers permit requirements and procedures outlined in the National Artificial Reef Plan, and (3) a state fishing management agency accepts liability for the remaining structure (30 C.F.R. §§ 250.1703, 250.1730). In addition, the National Fishing Enhancement Act of 1984 (NFEA), which authorizes the Corps of Engineers' permit program and the National Artificial Reef Plan (33 U.S.C. § 2101 *et seq.*), allows other organizations or agencies (such as the operator) to assume liability for the artificial reef, although MMS policy to date has required a state agency to accept liability.

The timing of future decommissioning activities is not fixed. It depends on the length of the lease, the rate of reservoir depletion, the market value of oil or gas, and whether the platform might serve an extended use for the operator, such as a gathering system for the production of other platforms. There are three stages in the decommissioning process: planning, permitting, and implementation. Platform decommissioning alternatives fall into four general categories: complete removal (the default option), partial removal, toppling, and leave-in-place (Figure 4.1). The suite of decommissioning alternatives that proposes to leave part or all of the abandoned platform structure in the marine environment is often collectively referred to as "rigs-to-reefs".

Alternative 1: COMPLETE REMOVAL

A typical full-removal project begins with well abandonment in which the well bores are filled with cement. The conductors are then separated from below the seafloor by being pulled, cut-off, or removed using explosives. Next the topsides, which contain the crew quarters and the oil and gas processing equipment, are cut from the jacket and removed. Finally, the piles that hold the jacket to the seabed are severed with explosives and the jacket is removed. Other typical decommissioning requirements include the removal or abandonment of pipelines and electrical cables and the removal of any debris from the seafloor.

After deciding to totally remove a platform from the seafloor, operators have several options (O'Connor 1999; van Voorst 1999; Gibbs 2000; Terdre 2000). (1) The platform can be taken to shore, where it is disassembled and the components either recycled, sold as scrap, or discarded in landfills or other depositories. To date, managers have selected this option for most decommissioned platforms. (2) The structure can be reconditioned and reused. As an example, in 1997 a platform was removed from the North Sea, taken to shore and cleaned, refurbished, shortened by 10 m (33 ft.), and installed in another North Sea location. A few small platforms have also been reused in the Gulf of Mexico. (3) A platform can be towed to another site and reefed. This has occurred a number of times in the Gulf of Mexico, with the most zealous example towing structures of two Tenneco platforms over 1480 km (920 mi) from offshore Louisiana to a site 1.5 miles off Dade County, Florida (Wilson et al. 1987).

Alternative 2: PARTIAL REMOVAL

In this scenario, the wells are abandoned, the topsides are removed, and the remaining jacket and possibly the shell mound are left in place to continue to function as an artificial reef. Navigation aids are added.

Despite what has been implied in other reports, conductors need not be completely removed. Dauterive (2000) notes "Recognizing the preservation of environmental values associated with the method of partial removal of the platform, the MMS in 1997 established a policy to allow the industry the option to partially remove

DECOMMISSIONING OPTIONS AND ISSUES

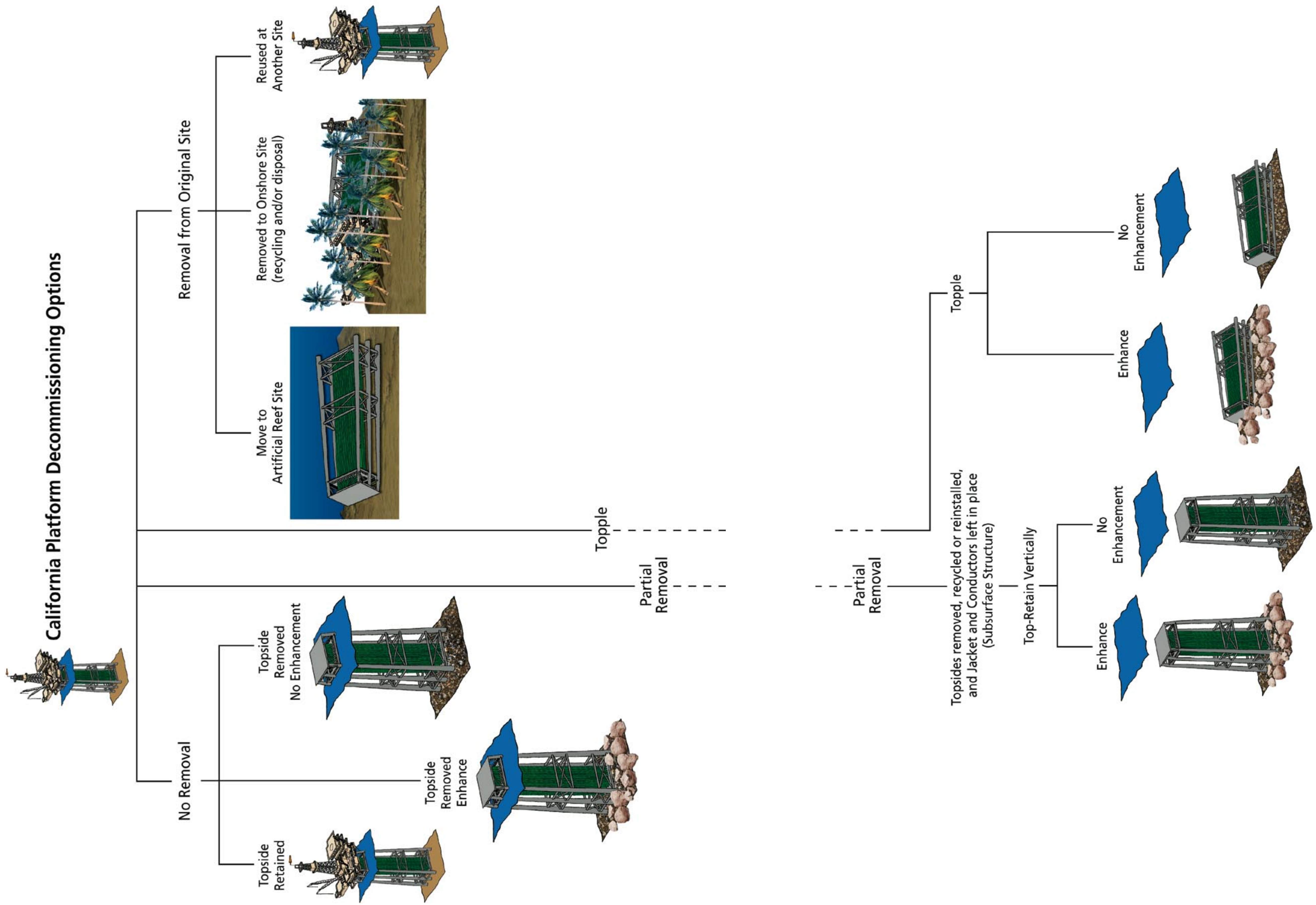

Figure 4.1. Platform decommissioning options.

the well conductors at the same depth below the water line (WL) at which the industry had proposed to remove the platform jacket." Retaining platform conductors has two consequences. First, it adds additional complexity to remaining structure. Second, explosives are usually used to remove the conductors and retaining these pipes eliminates the need for explosives (Dauterive 2000).

After cleaning, disposition of topsides may be handled in a couple of ways. It can be moved to a new platform and reinstalled, or it can be taken onshore, where the steel and other valuable components are recycled and other material sent to landfills. Certain parts of the topsides, such as the cleaned deck, have occasionally be used in forming artificial reefs.

Alternative 3: TOPPLING

As in partial removal, the wells are abandoned and the topsides are removed. The shell mounds may be either removed or left in place. The primary difference between partial removal and toppling is that, in toppling, explosives are used to sever the jacket from the seabed and then a derrick barge or pull barge drags the jacket over and it is allowed to settle to the seafloor (Twachtman 1997). Navigational aids, if necessary, are then put in place.

Alternative 4: NO REMOVAL (LEAVE-IN-PLACE)

A platform and its surrounding shell mound could be left in its original location at the time of decommissioning. The topside would be stripped and cleaned and navigational aids installed.

In the Gulf of Mexico this scenario has been discussed on a number of occasions, although it has not been attempted. For instance, a platform in the Flower Garden Banks National Marine Sanctuary was studied as a possible research laboratory. However, the cost of maintaining cathodic protection and navigational aids (together running to $300,000 per year) proved too high (L. Dauterive, personal communication). Other creative suggestions offered by stakeholders for decommissioned, left-in-place platforms include wind and aquaculture farms, meteorological stations, hospitals, hotels, gambling casinos, and penal institutions.

Agencies Responsible for the Decommissioning Process

By law, various coastal states and the federal government share the administration of submerged lands, subsoils and seabeds off the United States. Thus, depending on where platforms are positioned, responsibility for mineral extraction, including oil and gas development, is either under state or federal jurisdiction. Similarly, decisions regarding the decommissioning of platforms fall under either state or federal control, although the final decisions are based on consultation and mutual agreements among a number of agencies.

Responsibility for the fate of platforms in federal waters rests with the MMS (33 U.S.C. § 1331 *et seq.*) Federal agencies that are consulted in the decommissioning process include the Environmental Protection Agency (33 U.S.C. §§ 1311(a), 1342), Army Corps of Engineers (33 U.S.C. §§ 403,1344), National Oceanic and Atmospheric Administration (NOAA) Fisheries (16 U.S.C. § 1801 *et seq.*), and Coast Guard (14 U.S.C. § 85: 43 U.S.C. § 1333(d)). State agencies, such as the California Department of Fish and Game do not have jurisdiction in federal waters but may comment in the decision making process. Under the federal Coastal Zone Management Act (16 U.S.C. § 1451 *et seq.*), MMS decisions on platform decommissioning that will affect coastal resources are also reviewed by the appropriate state agency for consistency with the state's coastal zone management program. In California, the California Coastal Commission conducts review for consistency with the state program. In turn, state agency consistency decisions can be appealed to the U. S. Department of Commerce (16 U.S.C. § 1456(c)(3)(A), (c)(3)(B)(iii); 15 C.F.R. Part 930, subpart H).

Decisions regarding the decommissioning of platforms in California state waters are the province of the State Lands Commission (Cal. Pub. Res. Code § 6216), along with such agencies as the California Coastal Commission (Cal. Pub. Res. Code § 30330), Department of Fish and Game (Cal. Fish & Game Code § 1602), local Air Pollution Control Districts (Cal. Health & Safety Code 40000), U. S. Army Corps of Engineers (33 U.S.C. §§ 403, 1344), and the U. S. Coast Guard (14 U.S.C. § 85).

Jacket and conductor removal: the role of the U. S. Coast Guard in decommissioning

Local United States Coast Guard districts are responsible for the safety of vessel traffic in their respective geographic areas and have the authority to dictate aids to navigation for obstacles in the water (14 U.S.C. §85; 43 U.S.C. § 1333(d); 33 C.F.R. Part 67). Therefore, in instances where some part or all of a platform is to be reefed, the Coast Guard will specify the necessary navigational aids. Discussions regarding decommissioning of platforms off California have often erroneously assumed that the Coast Guard will require that the jacket be removed to about 26 m (85 ft.) below the surface. However, decommissioning experience in the Gulf of Mexico demonstrates that there is no set removal depth. Indeed, the Coast Guard decision-making process appears to be quite flexible; it reviews each decommissioning on a case-by-case basis. For instance, in the decommissioning of the mile-long Freeport-McMoRan sulfur mine platform and bridge off Louisiana, the Coast Guard required piles to be cut 9 m (30 ft.) beneath the surface (Kasprzak 1999).

Generally, the requirements for aids to navigation become more restrictive (and therefore more expensive) the closer to the surface the obstacle lies. As an example, here is a generic set of conditions for decommissioned platforms in the Gulf of Mexico based on recent Coast Guard decisions (G. Steinbach, personal communication):

- If the obstacle is greater than 61 m (200 ft.) in depth: no requirement for aids to navigation
- If the obstacle is from 61 m to 26 m (200 ft. to 85 ft.) in depth: unlighted buoys are required
- If the obstacle is 26 m to 11 m (85 ft. to 35 ft.) in depth: lighted buoys are required
- If the obstacle is from 11 m (35 ft.) to protruding through the surface: lights or lighted buoys and foghorns are required.

In the rigs-to-reefs programs in the Gulf of Mexico, the states are responsible for aids to navigation on reefed platforms. The costs of these aids are paid for from the funds created by the industry's donations. As a cost savings measure, these states generally have selected greater water clearances. The requirements for California waters may be different from those in the Gulf of Mexico. The local Coast Guard District will determine these requirements based on vessel traffic and other local conditions.

The question of liability for a reefed platform off California

Liability, who retains responsibility for a reefed platform, is a major issue in the decommissioning process. MMS policy states the "The MMS supports and encourages the reuse of obsolete offshore petroleum structures as artificial reefs in U. S. Waters." Current MMS regulations provide that a platform operator may be released from removal obligations in the federal lease instrument if a state agency responsible for managing fisheries resources will accept liability (30 C.F.R. § 250.1730). However, in situations where reefs are not managed by a state agency, another organization or agency must assume liability, as provided in the National Fishing Enhancement Act of 1984 (Stone 1985). In such cases, liability could possibly be retained by the oil company, transferred to a private entity, or handled in some other manner as long as MMS approval is received (G. Steinbach, personal communication).

An extensive body of policy and research outlines proper procedures for siting and deploying artificial reefs, and this information bears upon liability of such structures. The National Artificial Reef Plan (NARP) states "When a reef has been properly located, marked on navigation charts if necessary, and any required surface markers affixed, there should be very little potential for liability" (Stone 1985). Regarding accidents, which may occur during recreational activities near artificial reefs, the NARP further declares, "Diving accidents may occur with use by recreational divers. In this respect, an artificial reef is like a public park — there are dangers in those parks, guardrails and fences cannot be placed everywhere, and everyone who visits the park assumes some risk of injury. A warning could be placed on nautical charts and posted in local dive shops to warn of these dangers. However, each case would probably involve determination of comparative negligence" (Stone 1985). Parker (1999) notes that no lawsuits have ever been filed against the California Department of Fish and Game with respect to their artificial reef program.

Regardless of which decommissioning alternative is selected, the federal government cannot be held liable. Regarding State liability, the NARP notes, "If the permit holder is a State government, it may have sovereign immunity from liability. It is unclear whether the National Fishing Enhancement Act affects any State's claim of sovereign immunity." (Stone 1985)

National Artificial Reef Plan

Decommissioning options other than complete removal must be consistent with the National Artificial Reef Plan (33 U.S.C. § 2104(a)(4)). The National Fishing Enhancement Act of 1984 directed the development of a long-term National Artificial Reef Plan (NARP) to provide guidance and criteria on planning, construction, and evaluating artificial reef use, as well as introducing liability and mitigation issues (33 U.S.C. § 2103). Goals of the NARP seek to enhance fishing and fishery resources and minimize user conflicts and environmental risks without creating unreasonable obstruction to navigation (33 U.S.C. § 2102). In 1998, the NARP was supplemented by the Coastal Artificial Reef Planning Guide, which incorporates new language from relevant federal and state agencies, fishing interests, and the general public.

California Department of Fish and Game Rigs-to-Reef Guidelines

"These guidelines stipulate that the project must benefit living marine resources, habitat, and user groups; that disposal or use of contaminated materials is not permitted; that wherever possible the subsurface structure of the platform should remain in place; that where possible subsurface structure that must be removed could be relocated to the base of the rig or other appropriate sites; and that the remaining structure be augmented by rocks or other materials to assure that the site functions as a diverse and productive reef habitat. To replace the biotic productivity from that part of the platform removed for navigational purposes, rock or concrete reefs should be placed in nearshore locations. A rigs-to-reef project sponsor must provide sufficient funds to the Department to evaluate the benefits to biotic productivity, user groups, and the overall management of fishery resources." (Holbrook et al. 2000)

Social Values in Platform Decommissioning

Defining the social and ecological goals of decommissioned platforms as artificial reefs will be critical in evaluating the efficacy of any potential rigs-to-reef program and the current and future performance of any artificial reef. Therefore, it is likely that various stakeholder groups will vie in defining the goals (and therefore the usefulness) of decommissioned platforms as artificial reefs. In this report, we sort the multitude of stakeholder viewpoints regarding a rigs-to-reef program into three groups, each of which is primarily defined by one concern: community membership, resource accessibility and environmental (marine life) issues. Of course, an individual may be influenced by more than one social value, and others may use arguments from multiple categories to promote a desired decommissioning outcome.

The first group consists of stakeholders who are concerned about community membership, and either oppose or support local presence of the oil industry. Those that wish to promote a community without the oil industry often view reefing alternatives as bundled together with all oil industry activities (e.g., continued exploration and production), the whole of which should be locally opposed (although they may not be opposed to oil industry activities in the Gulf of Mexico). For example, Camozzi (1998a) states that complete removal should be the preferred alternative in decommissioning because, after decades of fighting oil development on the California Coast, it acts as a "catharsis" for the local community. Camozzi (1998b) reiterates this point by stating that, in regard to mussel mound removal, "Sending a message to oil companies that they must clean up our coast when they are done extracting their profits is the most vital issue in this case." Individuals who wish to encourage or maintain the presence of the oil industry in the local community, presumably for economic reasons, favor some sort of reefing option because reefing is less expensive than complete removal (Pulsipher et al. 2000). Further information regarding local community views on the oil industry in California can be found in Lima (1994) and Smith and Garcia (1995).

The second group of stakeholders is primarily concerned with resource accessibility. A heterogeneous group, these citizens will either favor or oppose decommissioning alternatives depending on how these alternatives aid or inhibit their ability to access a particular resource. For example, commercial trawlers in the Southern California Bight favor complete removal because fishing gear may snag on platform structure or shell mounds (Southern California Trawlers Association 1998; McCorkle 1999). Other commercial fishers benefit from oil industry activities. Shrimp trawlers in the Gulf of Mexico drag within 0.4 km (0.25 mi) of platform structures, reporting that these fishing grounds tend to be more productive (Wilson et al. 1987). The rocky habitat associated with Rincon Oil Island in California provides excellent lobster fishing grounds and trap fishers would oppose seeing this habitat removed (Miller 1999). Recreational fishers often dominate the debate surrounding platform decommissioning, and they have driven the formation of artificial reef policy at both state and federal levels (Stone 1985; Wilson et al. 1987). Many recreational fishers favor a reefing alternative in decommissioning because catch per unit effort is often high at offshore platforms for targeted fish species such as kelp bass (Love and Westphal 1990; McCrea 1998). In the Gulf of Mexico, Reggio (1987) estimates that 70% of fishing excursions target oil platform habitats. Citizens participating in non-consumptive activities also possess a variety of viewpoints regarding decommissioning alternatives. Many scuba divers find that underwater portions of oil platforms provide outstanding diving and underwater photographic opportunities, and favor decommissioning alternatives that preserve such opportunities, (Vallette 1999). Other members of the public may view the topside structure of platforms as denying them access to unobstructed, scenic ocean views, and consequently they oppose the leave-in-place decommissioning option (Wiseman 1999).

The third stakeholder group makes decisions regarding decommissioning based on their perception of how certain marine populations or environmental ideals fare under the various decommissioning alternatives. It is this last group that is most likely to use ecological information in making decisions regarding platform decommissioning. A decommissioning option that involves reefing may be supported if a substantial net benefit to the marine environment can be demonstrated (Chabot 1999). Others support complete removal because this option is the only one which promotes a wilderness ideal, that is, a marine environment which fails to retain a visible mark of human activities. If there is a lack of scientific evidence regarding ecological consequences, or if they are unaware of such consequences, these stakeholders may use another social value, such as community membership, in choosing a preferred decommissioning alternative (Chabot 1999).

Economic incentives interact and overlap with social values. In past rigs-to-reefs activities, industry and state entities have equally shared the cost-savings resulting from partial removal or toppling alternatives. Partial removal of deep water platforms will generate estimated savings of one to two orders of magnitude greater than the amount saved in decommissioning smaller platforms. The cost of maintaining navigational equipment (if any is needed) at these reefed platforms will not increase in the same proportion as the increase in cost-savings, and may actually decrease. These additional financial resources may be used to develop or enhance projects of interest to stakeholders, and may be a sufficient incentive to alter the preferred decommissioning option for some groups.

The Interaction of Science, Scale, and Social Values

State and federal regulatory agencies involved in the decommissioning process are required to protect the public interest when managing natural resources. In the face of strongly conflicting viewpoints among stakeholder groups, resource managers may try to convert a controversial issue into a technical one. For instance, they may give preference to the protection of marine life resources, thereby avoiding the appearance of favoring one group's economic concerns over another's. Additionally, legislation such as the Endangered Species Act and the Marine Mammal Protection Act, among others, often give environmental concerns priority over social and economic concerns. In combination, these issues give ecological information a prominent role in the decommissioning process.

Impacts to the environment may be measured at short or long time scales, or within a local or regional context. As time and space scales increase, so does scientific uncertainty about predicting consequences of various management alternatives (due to an increasing number of unknown variables and propagation of error associated with imprecise assumptions or model parameters). When there is greater scientific uncertainty, social values and political or economic factors often become more important in the decision-making process. This phenomenon may result in stakeholders advocating that ecological performance of reefed platforms be evaluated at scales which enhance the possibility of their preferred decommissioning alternative, even if ecological data are irrelevant to their concerns.

For example, proponents of regional ecological assessment at long time intervals may be individuals who oppose the local presence of the oil industry. Since regional assessment is difficult and expensive to accomplish, social values (e.g., antagonistic views of oil industry) will increase in importance. Significantly, these same individuals have not stipulated that other artificial reefs which are similar to reefed platforms, such as steel hulled ships, undergo the same rigorous ecological assessment. Further, the assured instantaneous and lethal effects of explosives are not considered in arguments about marine life effects.

Proponents of small scale ecological assessment tend to be recreational anglers, who often state their support for rigs-to-reef programs in terms of benefits to the environment. They maintain that the local presence of abundant marine life at a platform is sufficient evidence of satisfactory ecological performance. But this support for a rigs-to-reef alternative often evaporates if artificial reefs are designated no-take areas.

Ecological information greatly aids the decision-making process if explicit management goals are specified. The rebuilding of depleted fish stocks might be one goal, the preservation and expansion of marine wilderness might be another. Determination and ranking of ecological goals reflects cultural values. Thus, controversies surrounding platform decommissioning cannot easily be translated into technical issues by giving priority to ecological goals because we lack agreement on the space and time scales in which ecological impacts should be measured. Therefore, the scale at which ecological impacts are measured (local or regional) and considered (short or long term) becomes paramount in the decommissioning process. To date, such specific space and time scales have not been designated by any state or federal government agency.

MILTON LOVE

Juvenile cowcod on pipeline.

Decommissioning Activities in the Gulf of Mexico

To date, almost all platform decommissioning and reefing in the world has occurred in the Gulf of Mexico. Because large-scale offshore drilling first took place in the Gulf of Mexico, it was in this region that the issue of what to do with unwanted platforms first arose. Below, we give a brief summary of the history of decommissioning in the Gulf of Mexico; additional details are found in Lukens (1997), Kasprzak (1998), and Dauterive (2000).

Kerr-McGee erected the first offshore oil and gas platform in the Gulf of Mexico off Louisiana in 1947. Despite its primitive structure and placement in waters only 6 m (18 ft.) deep, oil was struck 22 days after drilling began, presaging a veritable tidal wave of offshore drilling. In 2001, there were over 4,000 platforms in the Gulf of Mexico, the vast majority occurring off Louisiana, followed by Texas, Mississippi and Alabama (Lukens 1997; Moritis 1997; Kasprzak 1998, 1999; Dauterive 2000). Platforms provide a considerable amount of the hard substrate in the north-central Gulf of Mexico, and surveys indicate that 20%–50% more fish live around platforms than on surrounding soft seafloors (Gallaway and Lewbel 1982; Driesen 1985). Because recreational and commercial fishers target fish residing near these structures, they are of considerable economic value (Dimitroff 1982; Reggio 1987; Kasprzak 1998).

By the late 1970s, it was apparent that the economic life span of many of these structures was nearing an end. During that decade, about 150 platforms were removed to shore and scrapped. The first reefing of an oil and gas structure occurred in 1979 when a subsea production system was towed from Louisiana to an artificial reef site off the Panhandle of Florida. In 1982, an obsolete platform jacket was moved from Louisiana to a Dade County, Florida site and over the next few years several additional structures were moved to various artificial reef sites.

Responding to this new activity, Congress passed the National Fishing Enhancement Act (NFEA) in 1984 (33 U.S.C. § 2101 *et seq.*). The NFEA mandated the creation of a "long-term plan for siting, constructing, permitting, installing, monitoring, managing, and maintaining artificial reefs within and seaward of state jurisdictions" (Kasprzak 1998). This document, later called the National Artificial Reef Plan, was published in 1985. In response to NFEA, several Gulf of Mexico states have now passed laws to take advantage of platform decommissioning to help preserve complex habitat in the northern Gulf of Mexico, for example, the Louisiana Fishing Enhancement Act of 1986 (La. Rev. Stat. § 56:639.1 *et seq.*) [Act 100] and the Texas Artificial Reef Act of 1989 (Tex. Parks & Wildlife Code § 89.001 *et seq.*). As an example, Act 100 created a process by which ownership of and liability for uneconomical platforms could be transferred from operators to the state of Louisiana. As noted by Kasprzak (1998), "Act 100 established the State of Louisiana as the permittee for artificial reefs developed under the program's jurisdiction and appointed the Department of Wildlife and Fisheries as agent for the state. The state assumes responsibility for the reefs upon placement within the established reef permit area…Act 100 does not authorize state general funds for the artificial reef program but does establish the Louisiana Artificial Reef Trust Fund. Oil and gas companies that donate structures to the program are asked to contribute half of the disposal savings realized through program participation to the trust fund." A similar program exists in Texas (Texas Parks and Recreation 1999).

A significant amount of money has been collected in rigs-to-reef programs in both Louisiana and Texas. As of 2001, there was about $15 million in the Louisiana fund and at least $4 million in Texas. Contrary to what has been reported (McGinnis et al. 2001), major artificial reef programs of several states, including Louisiana and Texas, receive neither state nor federal funding, they are fully underwritten by the interest paid on their respective rigs-to-reef accounts (J. Culbertson, personal communication; R. Kasprzak, personal communication). The Louisiana Department of Wildlife and Fisheries and Texas Parks and Wildlife Department describe their rigs-to-reefs programs at http://www.wlf.state.la.us (under "Marine Fisheries") and http://www.tpwd.state.tx.us/fish/reef/artreef.htm, respectively.

Since 1942, over 188 Gulf of Mexico platforms have been reefed, primarily off Louisiana and Texas. This represents about 8.4% of all decommissioned platforms (L. Dauterive, personal communication). The reasons for this early low reefing rate were economic. Most of the platforms thus far decommissioned were in shallow water, and it was more cost effective to haul them onshore for salvage or reuse rather then tow them to reefing sites. In the future, it is likely that a higher proportion of platforms will be reefed as more offshore structures become obsolete. Of the platforms that have been reefed, about 60% have been removed from a site and towed to a new location. Contrary to what was stated by Krop (1998), some decommissioned platform structures have been left in place. Thus far, 30% have been toppled in place and the remainder have been partially removed and left standing (Dauterive 2000). As larger platforms in deeper waters are decommissioned, L. Dauterive (personal communication) has noted a trend towards partial removal, rather than towing or toppling. In all but a few instances, only the platform jacket has been used as reef material.

The Future: Ecological Consequences of Offshore Platform Decommissioning in California

Complete Removal (Total Removal) of Platform

The immediate impact of removing and hauling an entire platform to shore is that all attached animals die. If some of the platform structure is hauled to a reef area and replaced in the water, some of these animals may survive, depending on water depth and the length of time the structure is exposed to the air.

Using explosives to separate the jacket from the seafloor kills large numbers of fishes, although limited research makes it difficult to predict how many deaths will occur. Marine mammals and sea turtles may also be indirectly killed by damage to the auditory system. In a study in the Gulf of Mexico (Bull and Kendall 1994), explosives were placed 5 m (15 ft.) below the seafloor to sever the well conductors, platform anchor pilings and support legs, of a platform in about 30 m (100 ft.) of water. All of the fishes on or near the bottom and most of the adult fishes around the entire platform suffered lethal concussion.

Some shallow-water platforms can be removed without explosives. However, "The oil and gas industry has attempted to find alternatives to the use of explosives, such as cryogenic cutting, hydraulic abrasive cutting, mechanical cutting, and torch cutting. Most of these techniques either have proven to be ineffective or are successful only in limited situations. At present, the industry maintains that the use of explosives is by far the safest, most reliable, and most cost-effective method of platform removal" (Kasprzak 1998). A recent assessment of techniques for removing platforms (NRC 1996) found that it is unlikely that any techniques or devices now known will significantly reduce fish kills during removal operations that use explosives.

Shell Mounds at the Base of Platform

The jackets and conductors of all platforms off southern and central California are heavily encrusted with invertebrates, including mussels, barnacles, seastars, rock scallops, rock oysters and jingle shells, sea anemones, caprellid amphipods, rock crabs, limpets, gooseneck barnacles, and sessile tunicates. An extremely thick layer of mussels extends from the intertidal zone to depths of at least 30 m (100 ft.) (and deeper on some platforms). The seafloor surrounding the platforms is covered with mussel shells. This "shell mound" or "mussel mound" is created when mussels, and other invertebrates, are dislodged during platform cleaning or heavy swells. Our observations show that, depending on bottom depth, a number of species of invertebrates, including many species of seastars, brittle stars, and rock crabs, as well as king crabs, opisthobranchs, shrimps, octopi, and sea anemones are abundant on the shell mounds. Substantial number of fishes, primarily the juvenile stages of various rockfishes, adult stages of dwarf rockfish species, as well as lingcod, poachers, painted greenling, and other benthic species also inhabit shell mounds.

Around four platforms in shallow water locations (+/- about 33 m, 109 ft., water depth), the shell mounds were found to be many meters thick, and were found to cover accumulations of drilling muds and cuttings. Investigations of the shell mounds around deep-water platforms have not been completed. Nevertheless, because of the potential for environmental harm, this issue must be addressed for all platforms regardless of the decommissioning option pursued. The level of contamination, while localized, has been shown to vary from platform to platform. Therefore, any remedial actions taken during the decommissioning process will likely be determined on a case-by-case basis. Although the regulatory requirements are still evolving, the alternatives being discussed include leaving the shell mounds undisturbed, smoothing and shaping them to allow for trawling, capping the shell mounds with an impervious material, adding material to the mounds for enhancement, or completely removing the shell mounds.

The removal of shell mounds may have a number of consequences to marine life by (1) removing habitat and (2) the potential for releasing toxins into the water column during the removal process. The biological consequences of either removing, altering, or leaving the shell mounds in-place must be given appropriate attention in the decommissioning process.

Partial Removal of Platform

Since partial removal reduces or eliminates shallow water habitat from the platform structure, this alternative would likely result in lower species composition and diversity than at the start of decommissioning process. Response of biotic communities will depend upon how much of the upper portion is removed. Depending on the platform, fewer nearshore reef fishes, such as surfperches, basses, and damselfishes may occur. Invertebrates that only reside or recruit to shallow water habitat would also be absent. Since the majority of mussels are located at shallow depths, shell mound replenishment will be reduced or absent, and affect the persistence of that community.

Since partial removal does not require the use of explosives, there is relatively little marine mammal, sea turtle, fish and invertebrate mortality compared to complete removal. Vertebrate and invertebrate assemblages associated with the remaining platform structure are assumed to be minimally affected.

A number of misunderstandings surround predictions regarding the potential ecological consequences of partial removal.

(1) Some stakeholders and policy analysts have erroneously assumed that Coast Guard regulations require a minimum depth below the ocean surface to which a reefed platform must be reduced. However, as noted earlier, the decision on how much of the jacket and conductors is left in place is based on both a Coast Guard assessment and the willingness of the liability holder to pay for the requisite navigational aids. As mussels become rare below 30 m (100 ft.) on most platforms, the mistaken assumption that all topped platforms must be cut to 24–30 m (80–100 ft.) below the surface has led some to conclude that partial removal will inevitably lead to a severe reduction in the amount of mussels that fall to the bottom and, thus, to a change in or end to the shell mound community. This is not necessarily the case.

(2) Some reports suggest that partial removal will lead to a large decrease in juvenile rockfish densities; our research does not support this supposition. On the offshore platforms in the Santa Barbara Channel region, the juveniles of most rockfish species (particularly blue, bocaccio, halfbanded, olive, pygmy, squarespot, starry, widow, and yellowtail) are uncommon in waters shallower than 26 m (85 ft.). Partial removal could reduce fish densities if pelagic juvenile stages of these rockfishes first encounter a platform in shallow surface waters, then swim downwards below the 26 m range, causing pelagic juveniles to "miss" a platform. However, young-of-the-year rockfishes of many of these species recruit from the plankton in large numbers both to natural outcrops in nearshore waters and to those coming out of deeper waters that have crests in about 30 m (100 ft.) of water. This indicates that emergent structure is not necessary for these juveniles to locate suitable habitat.

On the other hand, the pelagic stage of a few rockfish species, particularly copper, gopher, black-and-yellow, and kelp may prefer to recruit shallower portions of the platform than other rockfish species (Holbrook et al. 2000; this report). These species recruit to nearshore rocky outcrops and kelp beds and do not appear to settle in deeper waters (Larson 2002a,b). For these species, partial removal of a platform would probably decrease juvenile recruitment, depending on the uppermost depth of the remaining structure.

(3) Errors regarding factors affecting juvenile fish mortality have also lead to confusion. McGinnis et al. (2001), in describing the history of artificial reef research in California, states that "Research has shown that high relief, open structures serve best to attract fish, and better enable fishery exploitation, while low relief, complex structured reefs provide better nurseries and afford more diverse assemblages of fish and other organisms". McGinnis et al. (2001) also cite an anonymous California Department of Fish and Game biologist who notes that "a drawback to rigs as reefs is that they are high relief, which works against survival of young-of-the-year fish, suggesting they may not be a source of production but rather simply an attraction site."

We know of no research that can support the above claims, and the authors do not cite any specific studies. Predators are the main source of juvenile fish mortality in marine systems; death due to starvation or exposure is rare. Thus, variation in habitat structure would modify juvenile fish survivorship by modifying the success rate of predators. Presently, no studies have assessed comparative performance in survivorship rates between platforms and natural habitats. Alternatively, we may begin to infer potential predator vulnerability between habitats by examining the ratio of juvenile fishes to piscivorous fishes. In the shallow portion of Platform Irene, the ratio of juvenile rockfishes to piscivorous fish is about 25:1 and at nearby Tarantula Reef it is 3:1 (Appendix 2; Schroeder, unpublished data). Conversely, in the east Santa Barbara Channel, at Platform Gina the ratio is 1:5, and at Portuguese Rock, Anacapa Island it is 1:1.4.

Toppling of Platform

Toppling would produce reefs with somewhat different fish assemblages than what has been observed around intact platforms. Consequences of removal of shallow water habitat would be similar to that of partial removal. In California, because most platforms reside in fairly deep water, toppled platforms would also harbor fewer young-of-the-year rockfishes, just as the reefs adjacent to Platform Hidalgo harbor fewer of these animals. Depending on the characteristics of the platform, a toppled structure, with twisted and deformed pilings and beams, might have more complexity than an upright one. This might increase the number of such crevice dwelling fishes as pygmy rockfishes.

No Removal (Leave-in-Place) of Platform

The no-removal option would allow the platform and shell mound to continue to function as they had when the structure was occupied. Decommissioning activities would result in small mortality impacts to resident marine populations.

What is the Life Span of a Reefed Platform?

How long can a decommissioned steel platform survive in the marine environment before rusting away? Operating steel platforms are protected by sacrificial anodes, often made of aluminum or zinc, which preferentially corrode before steel, thus preserving the jackets' integrity. This cathodic protection lasts as long as the anodes are intact, usually for a number of decades. It is assumed that, once a platform is reefed, there will be no additional replacement of the sacrificial anodes, although the issue has yet to be addressed for platforms off California. While corrosion rates vary in seawater, depending on water temperature, biofouling and other factors, it is estimated that the life span of a cathodically unprotected platform will range from a minimum of 100 to more than 300 years (Quigle and Thorton 1989; Mishael 1997; Voskanian and Byrd 1998).

Pipelines Associated with Platforms

Pipelines run from all platforms either to shore or to other platforms that collect the oil or gas and then ship it to shore. McGinnis et al. (2001), note that "Both Federal and California regulations allow decommissioned OCS pipelines to be abandoned in place so long as they do not constitute a hazard to navigation, commercial fishing or unduly interfere with other uses of the OCS." (See also 30 C.F.R. § 250.1750; Ca. Pub. Res. Code § 6873.) In the Gulf of Mexico, few pipelines have been completely removed in the course of decommissioning (Breaux et al. 1997).

In 2001, using the research submersible *Delta*, we conducted pilot surveys of a pipeline between Platforms Gail and Grace. We found this pipe to be heavily encrusted with such invertebrates as anemones, crinoids, basket stars, and seastars. We also noted relatively large numbers of fishes, particularly juvenile or dwarf fishes, including cowcod, flag, blackgill, striped, and vermilion rockfishes, along with poachers and flatfishes. Both fish and invertebrate densities were much higher than found on the surrounding mud bottom.

Resource Management Issues Associated with Decommissioning

Habitat Enhancement of Reefed Platform Structure

The California Department of Fish and Game has issued guidelines for rigs-to-reef projects that call for enhancing the remaining structure using quarry rocks or other material (Parker 1998). Adding such material would increase the number of crevices and hiding places suitable for smaller sized fish. Thus, species which are rare or absent from observed platform fish assemblages, such as pygmy rockfish, may then occur. The ecological community response may depend on the type of habitat enhancement and has not been examined.

Marine Protected Areas

To a certain extent, the platforms in the Santa Barbara Channel and Santa Maria Basin currently act as de facto marine protected areas (Schroeder and Love 2002). Fishing pressure around many of these platforms is relatively low because (1) some platforms are relatively far from harbors and thus from fishing vessels, (2) four platforms (Irene, Hidalgo, Harvest, and Hermosa) are located near Point Conception in waters that are extremely rough for much of the year, and (3) it is difficult to fish close to operating platforms because tying up to these structures is discouraged by platform operators.

Clearly, many reefed platforms would be a target for recreational anglers or commercial fishermen because platforms often host sizable local populations of sought-after fish species. Off Florida, Shinn and Wicklund (1989) suggest that patterns of large fish at Tenneco platforms may be in part determined by fishing activities. Thus, in California, it has been proposed that reefed structures be designated as no-take areas (California senate bill introduced by D. Alpert). In addition, it may be possible to modify the architecture of reefed platforms to make them difficult to fish. For instance, because most of the target species are found inside the bottom of platform any structure above the bottom would prevent gear from reaching the seafloor, thus inhibiting the capture of many fishes.

Decommissioning Alternatives in Relation to National Marine Fishery Service's Fishery Rebuilding Plans

The use of explosives to remove or topple a platform may compromise fishery-rebuilding programs. Cowcod provide one example. This species has been declared overfished by NOAA Fisheries (formerly known as the National Marine Fisheries Service) and is the subject of a federal rebuilding plan. The Pacific Fisheries Management Council has approved a cowcod rebuilding plan that limits fishery impacts to 1% per year (about 2.4 metric tons for 2001), as part of a 95-year rebuilding period, and the use of spatial closures south of Point Conception to reduce bycatch mortality. As noted earlier, our observations around Platform Gail indicate it has the highest density of adult cowcod and bocaccio of any natural or artificial structure surveyed. We can make an estimate of the number of cowcod at the bottom of Gail by multiplying the density of cowcod observed by the area of the platform's footprint (the area underneath the platform). For instance, in the last two years of the survey, 1999 and 2000, observed cowcod densities were 0.015 and 0.0183 fish per m^2, respectively. As Gail's footprint is 5,327 m^2 (Holbrook et al. 2000), extrapolation for 1999 and 2000 gives estimates of 79 and 97 individuals respectively. This conservative estimate does not include juveniles we have observed living on the shell mound or on the adjacent pipeline. The current rebuilding plan calls for both a quota on commercial and recreational fisheries combined of 2.4 metric tons, equal to about 600 fish (T. Barnes, personal communication). Assuming that Platform Gail has 75 or more cowcod living under it, and if, as seems likely from all known research, explosives used to remove or topple a platform will kill all of them, that loss may be sufficiently large to complicate the rebuilding plan (T. Barnes, personal communication).

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Spotted ratfish on shell mound at Platform Gail.