A Comparative Case Study Analysis Evaluating the Potential Success of a Rigs-to-Reefs Policy in Offshore California Waters given the Success of Similar Programs in the Gulf of Mexico

By: Claire Fitz-Gerald

Advisors: Patrick N. Halpin, Ph.D and Stephen E. Roady, Esq.

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Abstract

California recently passed a bill that will allow the partial decommissioning of oil and gas platforms in place, with the lower half retained to function as an artificial reef. This policy overrides previously existing legislation requiring complete platform decommissioning following the termination of oil and gas production. The decision to implement this policy was motivated by the financial gains promised to the state in guidelines developed by the National Artificial Reef Plan, as well as by the success experienced by rigs-to-reefs programs in the Gulf of Mexico. This case study analysis evaluated programs in Louisiana, Texas, and California to determine the applicability of successful Gulf of Mexico policies to the situation in California. The study uncovered significant differences between the two regions that reduced comparability between programs. Platform habitat in the Gulf of Mexico is an essential component of the ecosystem and significantly increases the amount of available hard substrate habitat, which thereby increases resident reef fish populations and supports the commercial fishing industry. Conversely, platform habitat in California comprises an insignificant portion of the available hard substrate habitat, and research indicates that platform communities result from a combination of settlement by organisms in a pelagic dispersal phase and attraction of organisms from surrounding natural habitats. The uncertainty regarding the ecological benefits of platform ecosystems obscures the potential repercussions of implementing a rigs-to-reefs program in California. Further research must be done to clarify the role of oil and gas platforms in California, as well as to fully understand their contribution to the regional ecosystem and the feasibility of utilizing them as a fishery enhancement device.

Introduction

The United States' marine region supports a variety of industries including commerce, national defense, transportation, fishing, and tourism, all of which contribute meaningfully to the success of our nation's economy. However, these activities also have a negative impact on existing marine natural resources. Heavy use of our oceans has resulted in the degradation of marine habitats and the depletion of commercially important species, and these issues must be addressed if we hope to sustain these resources for use by future generations. One approach to this problem is the establishment of additional habitat through the creation of artificial reefs. National legislation has been put in place over the last thirty years to support this endeavor.

In 1984, the National Fishing Enhancement Act was created for the express purpose of offsetting overfishing and habitat degradation by establishing artificial reefs designed to enhance existing fishery resources (NFEA 1984). The act required that all artificial reefs be designed, constructed, and sited in a manner consistent with existing laws and regulations, while facilitating resource utilization and minimizing conflicts between users (NFEA 1984). In an effort to standardize this process and establish consistent guidelines, the National Fishing Enhancement Act required the creation of a National Artificial Reef Plan within the following year (NFEA 1984).

The National Artificial Reef Plan was established in 1985, following the mandate set forth by the National Fishing Enhancement Act (NARP 2007, NFEA 1984). Policy-makers responsible for the National Artificial Reef Plan stressed the importance of careful planning, long-term monitoring, and data collection to assess environmental impacts resulting from reef creation. The introduction of an artificial reef into an environment will have a profound and possibly irreversible impact on the ecosystem; therefore, artificial reef siting must be preceded by careful consideration (NFEA 1984). A well-planned reef will be designed and sited to enhance available habitat and existing fish stocks, and accommodate use by stakeholders participating in activities such as recreational diving and fishing. Conversely, a poorly planned reef may result in undesirable effects such as hindering alternate uses, obstructing navigation, failing to support an ecosystem or damaging an already-present ecosystem, or requiring removal following damage or destruction to the environment (NARP 2007). To this end, the National Artificial Reef Plan provided criteria stipulating geographic, hydrographic, geological, biological, ecological, social and economic conditions, as well as requirements for artificial reef design and materials, a monitoring and management plan, a protocol for accepting reef material donations, and siting and permitting guidelines (NFEA 1984). These criteria set forth by the National Artificial Reef Plan serve as a framework intended to guide the development of individual state level artificial reef programs (NARP 2007). Thus, significant variation exists between artificial reefing requirements for different states, but the core elements are similar.

National Artificial Reef Plan Criteria Guidelines

Biological Considerations

The biological guidelines listed under the National Artificial Reef Plan include environmental factors known to be instrumental to the development of artificial reefs and necessary to achieve desired ecosystem conditions.

Bottom Substrate

Most importantly, existing productive habitats must be avoided when siting artificial reefs. This includes natural coral reefs, aquatic grass beds or macroalgae, oyster reefs, scallop, mussel, or clam beds, and other types of live bottom capable of supporting forms of marine life. Creating an artificial reef at the expense of an existing ecosystem would be counterproductive and detrimental on the whole. Soft sediments such as clays, silts, and loosely packed sand should also be avoided, because reefs sited on these materials risk being covered by sedimentation, and sinking if the bottom is not able to support the structure's weight. The preferred substrates for reef establishment are hard with minimal loose sediment cover. For example, either hard rock or hardpan bottoms would provide a suitable substrate. Prior to siting, an assessment of the bottom substrate will ensure that artificial reefs are located in areas conducive to success (NARP 2007).

Hydrography

The primary hydrological elements applicable to artificial reef siting include water depth, anticipated wave height, and expected current strength. Water depth at the proposed location will have the most substantial impact on ecosystem development. Species composition depends on the depth of the site and the environmental conditions present. Artificial reefs in clear or shallow water that experience good light penetration have demonstrated higher levels of productivity (NARP 2007).

Wave height and prevailing currents will have a similar impact on productivity at artificial reef sites, although the extent will vary with wave height and speed, current strength, and depth of the reef. Significant wave action at a site will stir loose sediments up from the bottom and result in cloudy water, which may hinder light penetration and ecosystem productivity (NARP 2007, Love et al 1999). To avoid such complications, experts siting reefs should assess wave action in the area and the type of bottom substrate present. Currents also affect reef productivity by distributing food and oxygen throughout the underwater system. When feasible, reefs should be oriented to take advantage of the prevailing currents' ability to transfer nutrient rich food and oxygenated water efficiently throughout the site (NARP 2007).

Water Quality

Factors such as turbidity, oxygen content and oxygen demand, water temperature, and nutrient loads and pollution all affect the potential success of artificial reefs. As discussed in terms of hydrography, turbid water may result in cloudiness, thereby decreasing productivity and visibility. Extremely turbid areas should be avoided. Similarly, areas experiencing anoxic conditions should be avoided, as periodic oxygen depletion will make it difficult for artificial reefs to achieve desired productivity levels. Finally, areas subjected to high nutrient loads or pollution should also be avoided as these conditions may pose a risk to human health and this possibility should be minimized (NARP 2007). The National Artificial Reef Plan especially emphasizes the need for sufficient background information on water quality to assess conditions at the chosen location prior to siting. If no such data exist, it must be obtained "through whatever means necessary prior to siting" (NARP 2007). The potential negative impacts to human health that would result from an inadequate assessment of water quality are too significant to be dismissed; therefore, a comprehensive analysis must be done for each site.

Construction Considerations

Materials used in the design and construction of artificial reefs are varied and dependent upon availability. The responsibility to approve or deny materials for reef construction rests with state authorities, although it is expected that they will abide by National Artificial Reef Plan guidelines and other existing federal regulations (NARP 2007). All approved materials should be inspected to ensure they meet the following requirements; they must be environmentally safe, structurally and physically stable, practical, and capable of being deployed in a manner that is both safe and cost-effective. Secondary use materials, or materials of opportunity, may be used provided they meet the conditions, although the use of materials such as ships has been controversial. Other examples include concrete, barges, oil and gas structures, and others. When assessing secondary use materials, it is necessary to consider the steps involved in siting it, such as cleaning the structure in preparation, transporting it to the site for deployment, and any other maintenance that may be required to ensure its successful conversion into an artificial reef (NARP 2007). Importantly, the NARP notes that many de facto artificial reefs already exist, such as shipwrecks and oil and gas platforms, and may already be sited appropriately and functioning as productive ecosystems (NARP 2007).

Function

Materials used in the construction of artificial reefs should be known to attract and support the targeted organisms; both sessile invertebrates that create the ecosystem, and fish species that are commercially and recreationally viable. Once suitable materials have been selected, the reef should be designed in a manner that will encourage growth and contribute to reef function (NARP 2007, GSMFC 2004). This includes developing a complex reef configuration, in which different types of structures are placed throughout the designated area to increase habitat and the diversity of species, and a varied reef profile, as the overall structure of the reef affects species composition and biomass (NARP 2007). Materials that are known to be incapable of supporting the desired array of marine life should not be deployed as artificial reefs.

Compatibility

Materials used for the creation of artificial reefs must be compatible with the marine environment. Any material that poses environmental risks should be dismissed in favor of an alternative material, unless other benefits provided by the material outweigh the risk. In this case, steps should be taken to minimize the potential risks. New materials with unknown risks should be assessed prior to siting to ensure that they do not pose significant unforeseen risks (NARP 2007, GASMFC 2004).

Stability

Materials used in artificial reef construction must be stable and resistant to movement. Areas with significant wave action may relocate reefs that are not solidly anchored and stable in their positions. Any movement from designated reef sites is a violation of permitting requirements and may pose a threat to vessel navigation and commercial fishing gear. Furthermore, easily moveable reef materials may be deposited on beaches, thus degrading coastal habitats (NARP 2007, GASMFC 2004).

Durability

Preferred artificial reef materials are resistant to deterioration and breakup. Over time, man-made materials in a marine environment will degrade and lose their structural integrity. Materials that are capable of weathering chemical and physical elements for an extended period of time without compromising their structure are ideally suited for artificial reef construction (NARP 2007, GASFMC 2004). Commonly identified suitable materials include steel and concrete (NARP 2007).

Site Selection Criteria

In addition to identifying optimal biological conditions and assessing various materials for use as artificial reefs, it is also necessary to select potential sites for consideration. Site selection should be based on both inclusion criteria, which identify areas that meet desired specifications, and exclusion criteria, which disqualifies areas that are incompatible for some reason.

Inclusion Criteria

The inclusion criteria set forth by the National Artificial Reef Plan are generally focused on fisheries, as the purpose of the National Artificial Reef Plan is to enhance fishery resources. The plan stipulates that the site selection process should include an estimation of anticipated reef use by interested parties, a list of target species expected to recruit to the site, accessibility to site from shore, and applicability of traditional fishing methods in the area (NARP 2007).

Exclusion Criteria

An area may be excluded from the artificial reef siting process if it is determined to be unusable for some reason. For example, an area with poor water quality or unstable bottom substrate would not meet the recommended biological considerations and should not be considered for artificial reef siting. Similarly, areas that have traditionally been assigned other uses that are incompatible with artificial reefs should be dismissed. This includes shipping lanes, restricted military areas, traditional commercial fishing grounds, and areas housing oil and gas pipelines or telecommunication cables (NARP 2007).

In addition to the above criteria, the National Fishing Enhancement Act and National Artificial Reef Plan address the issue of liability in artificial reef planning. The National Fishing Enhancement Act allows for discarded structures such as oil and gas platforms and shipwrecks to be repurposed for use as artificial reefs, provided that the title and liability for the structure is transferred to an entity with a demonstrated ability to assume long-term financial responsibility for any ensuing damages (NFEA 1984). Generally, the only entity that can provide proof of such ability is the state fishing management authority. Thus, regulations require that the appropriate state authority must accept responsibility for these structures (COST 2010, NFEA 1984). Consequently, state level plans must contain language allowing the appropriate state entity to accept responsibility for artificial reefs located in both state and federal waters (COST 2010, Stephan et al 1990, Wilson and Van Sickle 1987). According to National Artificial Reef Plan guidelines, ownership of a donated structure is transferred to the state following deployment, at which point the original owner relinquishes all responsibility for any damages that may occur. It is the state body's responsibility to ensure proper deployment of the structure. Once the structure is sited, its liability is minimal, provided that it does not disintegrate or become relocated from its designated site (NARP 2007).

Shortly after the establishment of this legislation, Gulf States began to develop state artificial reef plans that met the required regulations and incorporated the use of decommissioned oil and gas platforms. Oil and gas leasing and production activities are regulated by the Outer Continental Shelf Lands Act, established in 1953. The act awards authority over all lands and resources located within the Exclusive Economic zone to the federal government, including the right to lease and develop them (Cicin-Sain and Knecht 2000, OCSLA 1953). The Secretary of the Interior and the Bureau of Ocean Energy Management, Regulation, and Enforcement, formerly known as the Minerals Management Service,[*] are identified as the primary governing bodies; they oversee the leasing process and stipulate the terms, including the requirement that the lessee must fully decommission all structures and restore the seabed to its original, "natural" state

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[*] The term Minerals Management Service will be used in this evaluation for the purpose of consistency with other documents pertaining to oil and gas platform decommissioning.

following the completion of oil production (MMS (e) 2007, OCSLA 1953). However, there is language in the legislation that allows the retention of decommissioned rigs for conversion into artificial reefs in federal waters, provided that they abide by the requirements set forth by the National Fishing Enhancement Act, and they are incorporated into the state's existing artificial reef program (MMS (q) 2004, MMS (q) 2002). Thus, the Gulf States were able to draft appropriate legislation, and subsequent state artificial reef plans, that detailed the protocol for converting decommissioned platforms into artificial reef habitat (Stephan et al 1990, Wilson and Van Sickle 1987). In the years that followed, Louisiana and Texas emerged as world leaders in the establishment of rigs-to-reefs, boasting 83 sites composed of 120 decommissioned platforms in Louisiana, and 35 sites composed of 73 decommissioned platforms in Texas (Kaiser and Pulsipher 2005).

Artificial reefs in Louisiana and Texas were created using a combination of the two methods of rigs-to-reefs conversion: complete and partial platform decommissioning. In the complete platform decommissioning process, platforms are fully removed from the site according to Minerals Management Service regulations and towed to a designated artificial reef location (Dauterive 2000). First, the oil well is plugged using a cement block and the pipelines are abandoned, assuming they do not pose a safety hazard. Next, the deck is severed and removed, along with all drilling equipment. Finally, the jacket and conductors are severed from the seafloor using explosives and removed (see appendix I) (Kaiser 2006, Kaiser and Pulsipher 2005, McGinnis et al 2001). Explosives are commonly used to sever the platform structure from the seafloor because they are the cheapest method of doing so (COST 2010). However, detonating explosives underwater has proven negative impacts on marine life; studies estimate that the shockwaves generated will dislodge over half of the attached bivalves, kill the majority of the fish present at the site, and will interfere with the communication, migration, and feeding behaviors of any marine mammals in the vicinity (Scarborough-Bull et al 2008, Schroeder and Love 2004, Leidel 2002). The only difference in partial platform decommissioning is that the jacket and conductors are not severed using explosives, but instead retained in place to function as an artificial reef on site (Kaiser 2006, Kaiser and

Pulsipher 2005, McGinnis et al 2001). Partial platform decommissioning precludes the need for explosives and preserves the marine life present at the platform (Kaiser and Pulsipher 2005).

Recently, California passed an assembly bill implementing an artificial reef plan of its own (AB2503 2010). Twenty-seven offshore platforms exist in California waters, 23 in federal waters and 4 in state waters (see appendix II). All of these platforms are expected to reach the end of their economic productivity and require decommissioning in the next 15 years (Schroeder and Love, 2004, Frumkes 2002). The California platforms are located in depths ranging from 30 feet to 1198 feet, with weights that range from 1426 tons to 78,389 tons (see appendix III). These platforms are unique in that they are heavier and located in deeper waters than those located in the Gulf of Mexico and no decommissioning project of such magnitude has been completed to date (COST 2010). The disassembly costs and associated environmental pollutants are expected to be substantial (McGinnis et al 2001). As the time for decommissioning approached, lessees began to lobby the California Natural Resources Agency to consider possibly alternatives to complete decommissioning. Using the platforms as artificial reefs would allow the lessees to circumvent complete decommissioning requirements and would result in significant profits in the form of avoided decommissioning costs (COST 2010, Schroeder and Love 2004). According to National Artificial Reef Plan guidelines, the avoided costs realized by the donor of any artificial reefing structure must be shared with the state authority accepting liability for the structure (Schroeder and Love 2004, Kaiser and Pulsipher 2005). Driven by the current financial climate, and bolstered by the success of rigs-to-reefs programs in the Gulf of Mexico, California recently passed legislation allowing the partial decommissioning of offshore platforms to serve in an artificial reef capacity (AB-2503 2010). In California, the designated state agency selected to develop and implement the state artificial reef plan is the Department of Fish and Game (COST 2010). This study explores whether a rigs-to-reefs program in California has the potential to achieve the same level of success realized in Texas and Louisiana, the Gulf States that have benefited the most from their rigs-to-reefs programs.

Methods

The methodology used in this study was an archival comparative qualitative case study borrowing from the policy analysis tradition. The study is archival because the methods only utilized existing documents and sources and did not involve the generation of new data for use in future analyses (Baxter and Jack 2008, Eisenhardt 1989, Patton and Sawicki 1986).

Data collection included an exhaustive search of primary and secondary literature on oil and gas platform decommissioning in the Gulf of Mexico and California, documentation of ecological communities present at these oil and gas platforms, the social and economic implications of platform decommissioning, and existing federal and state legislation pertaining to artificial reefing and platform decommissioning. Primary sources were comprised of pertinent legislation and scientific papers published in peer-reviewed journals, and secondary sources consisted of reports synthesized by government-contracted bodies on platform decommissioning and artificial reefing. State artificial reef plans were assessed for key similarities and differences in their applications of the National Artificial Reef Plan framework, its associated factors, and their implications. Other primary and secondary literature sources were reviewed for data evaluating the states' varied approaches to the common themes. The expected common themes included in the documentation were: artificial reef siting, including construction materials and biological considerations, decommissioning decisions for rigs-to-reefs projects, including cost, proposed decommissioning methods, stakeholder involvement, and ecological implications.

Data concerning the expected themes were found for both sites, and there were relatively few similarities between the Gulf State plans and California plan. Literature on both locations highlighted cost as the key motivating factor, displayed support for platforms as suitable reefing materials, and identified fishing industries as prominent stakeholders. However, the social and biological climate surrounding rigs-to-reefs in the two locations differed substantially; state artificial reef plan siting protocols and existing ecological conditions exhibited significant variation that reduced comparability between sites. In particular, data on ecological conditions in California suggest a need for additional studies to fully understand the suitability of a rigs-to-reefs program.

Analysis

Construction Considerations

Both the Gulf State artificial reef plans and the California artificial reef plan support the use of decommissioned platforms as suitable construction materials in the creation of artificial reefs. This result should not be surprising as it is the basis for this study. Preferred artificial reef structures are often made of sturdy materials capable of weathering open ocean dynamics, such as steel and concrete, and are constructed in a manner that maximizes vertical relief and complexity (Seaman 2007, Rilov and Benayahu 2000). These sturdy structures are generally deployed in sandy-bottomed areas that are not heavily settled and are capable of supporting the weight of the reefs (Danner, E.M., T.C. Wilson, and R.E. Schlotterbeck 1994). In light of these criteria, it is understandable that oil and gas platforms function as artificial reefs; the complexity, vertical relief, and materials used to construct oil and gas structures are well suited to colonization by ecological communities, and platforms are generally located in areas with no existing live bottom and minimal sediment cover (Seaman 2007, Rilov and Benayahu 2000, Kaiser 2006, Stephan et al 1990).

Siting Considerations

Variations existed between the siting requirements stipulated for all three analyzed state artificial reef plans. The mandates set forth by the Louisiana plan are the most stringent. The Louisiana state artificial reef program pre-designated suitable locations using an extensive biological assessment, and a through site selection process that removed exclusion areas from consideration (Wilson and Van Sickle 1987). This process resulted in the identification of nine areas suitable for artificial reef siting (Kaiser 2006). Platforms selected for use as artificial reefs in Louisiana undergo one of two processes: if the platform is already located within a designated site it may be partially decommissioned with the lower portion retained for use as a reef, but if it is located outside of the designated sites, it must be fully decommissioned using traditional

Minerals Management Service guidelines and towed to an appropriate location for reefing (Kaiser 2006, Kaiser and Pulsipher 2005, McGinnis et al 2001).

Texas' state artificial reef plan provides more flexibility; like Louisiana, the Texas plan requires that potential artificial reef sites must undergo an assessment to ensure that they meet the necessary biological requirements, but their site selection process assumes that any site is suitable for use unless it is currently supporting another incompatible use (Kaiser and Pulsipher 2005, Stephan et al 1990). According to these guidelines, platforms located in areas that do not meet the biological requirements must be fully decommissioned and towed to a site that does meet the conditions, but those that do meet the biological requirements and do not conflict with existing uses may be partially decommissioned in place for use as an artificial reef (Stephan et al 1990).

Of all three plans, the siting requirements established by the recently passed California plan are the most lenient. This plan also assumes that any location is a suitable site, provided that it does not conflict with existing uses and meets biological requirements (AB2503 2010). Policy-makers and proponents of the plan have argued in favor of using only partial decommissioning in an effort to preserve the ecosystem present at each platform. Further, they argue that the presence of an ecosystem at the platform site is indicative of the area's ability to meet the biological requirements, thus alleviating the need for site assessment (Schroeder and Love 2004, Bull, Love and Schroeder 2008). The success these advocates have achieved is reflected in the California assembly bill, which allows partial decommissioning of all structures that adhere to the terms of the plan and makes no mention of implementing a complete decommissioning and re-location plan as well (AB-2503 2010). This method of siting fails to adhere to the structured process designed to govern artificial reef creation.

As expected, the decision to completely or partially decommission a platform is largely dependent on cost. Other factors that take precedence in decommissioning cost-benefit analyses include the expected time required to execute the project, and the anticipated risk of doing so. These factors are informed by comparable past decommissioning experiences (Kaiser 2006, Kaiser and Pulsipher 2005). If these factors are equivalent between the proposed options, then the more cost-effective option, complete or partial decommissioning, is chosen. This is measured by considering the size of the structure and water depth at the site, as the magnitude of the operation is directly related to these two factors. Decommissioning projects require the hire of various skilled laborers, including specialized machinery operators, scuba divers, and biological observers (COST 2010, Kaiser 2006). Platform decommissioning also requires the use of Heavy Lifting Vessels (HLV), ships capable of lifting and transporting large structures. Rates range from roughly $156,000 daily for HLVs intended for smaller loads to $252,000 daily for the larger HLVs (COST 2010). The structure's size and the water depth determine the number of workers needed and the size of the HLV to be used.

In Louisiana and Texas, selecting the more cost-effective option does not always result in the conversion of platforms into artificial reefs. Studies on decommissioning trends indicate that platforms located in shallow waters and those close to shore are cheaper to traditionally decommission and remove (Kaiser 2006). This is because platforms selected for artificial reefing in these states often must be fully decommissioned and transported to an appropriate site; a process that is only cost-effective if the platform is located closer to the reef site than to shore (Kaiser and Pulsipher 2005). According to data collected on rigs-to-reefs in the Gulf of Mexico, roughly eighty percent of offshore platforms are still fully decommissioned and removed from the marine environment (Kaiser and Pulsipher 2005).

Of California's twenty-seven platforms, four are located in shallow water or in proximity to shore such that it might be cost effective to decommission them, but the remaining twenty-three are large structures located in areas of substantial water depth (see appendix III). The Minerals Management Service compiled a technical report detailing the estimated costs of both completely and partially decommissioning California's platforms based on four water depths: 200, 400, 700, and 1200 feet (McGinnis et al 2001). The analysis assumed a 2000 ton platform for structures located in 200 feet or less of water, and a 5000 ton platform in all deeper waters. The approximate decommissioning costs for full removal determined by the study were 4 million dollars, 15 million dollars, 21.5 million dollars, and 49 million dollars, respectively, whereas the partial decommissioning alternative would reduce costs to roughly 2.4 million, 7.8 million, 8 million, and 15 million (McGinnis et al 2001). This comparison clearly illustrates the significant cost savings associated with partial platform decommissioning and highlights the financial incentive for benefiting stakeholders, such as the oil industry and the state, to pursue a partial decommissioning rigs-to-reefs strategy over a complete decommissioning and re-location strategy.

Biological Considerations

Offshore oil and gas platforms in the Gulf of Mexico and California both act as artificial reefs and support the development of complex biological communities. The creation of a platform ecosystem begins when sessile invertebrates transported by ocean currents are recruited to the structure (Siegel et al 2008). Invertebrates colonize the length of the platform, exhibiting variations in species composition and density with depth. The composition of sessile species at platform habitats generally includes mussels, barnacles, scallops, sponges, tunicates, corals and oysters (Scarborough-Bull et al 2008). Mussels are often dominant in the upper water column, but as depth increases, sea anemones and sponges emerge as the most prevalent species. Mobile species such as crabs, seastars, and sea cucumbers are also often present (Love et al 1999, Page and Hubbard 1987). These bivalve aggregations are generally referred to as “fouling communities” and are the basis of the ecosystems that develop on oil and gas platforms (Bram et al 2005). Some of the invertebrates attached to the platform become dislodged by waves or currents, animal interactions, or death, and these individuals fall to the base of the platform. Over time, the accumulation of these organisms will result in a large pile, or shell mound, underneath the platform. The platform and accompanying shell mound create a rocky substrate habitat that is preferred by reef fishes; consequently, diverse assemblages of species will colonize the habitat (Love et al 2007, Love et al 1999).

Platform ecosystems play an essential role in the Gulf of Mexico; the majority of the seafloor consists of soft substrates such as mud and silt, and the 4000 offshore oil and gas platforms located in the Gulf collectively comprise approximately 28% of the available rocky substrate habitat (Lindquist et al 2005, Sayer and Baine 2002). The platforms provide additional habitat that may allow recruitment by species that require hard substrate to settle (Lindquist et al 2005). Studies on platform communities in the Gulf also display differences between assemblages found on natural and artificial reefs, suggesting that pelagic larvae originally recruited to the platforms from great distances but now are sustained by the prevalence of platforms and recruit easily between structures (Scarborough-Bull et al 2008). Species composition varies between platforms but fish abundance at all platforms is consistently high and contributes to an overall increase of fish in the Gulf of Mexico (Stanley and Wilson 2000). Consequently, both commercial and recreational fishermen frequent the waters surrounding offshore platforms. Data collected on fishing in Louisiana waters indicated that platforms were the destination in 70% of all trips (Scarborough-Bull et al 2008).

In California waters, the small number of platforms and the relative abundance of natural rocky substrate habitat preclude platforms from contributing significantly to fish habitat (Scarborough-Bull et al 2008, Karey 2001). Rockfish are the dominant species group found at platforms, with up to 42 species observed at some locations (Scarborough-Bull et al 2008, Love et al 1994). Other commonly observed species include greenlings, damselfishes, lingcod, and sea perches (Caselle et al 2002, Love et al 1999). Scientific research conducted at platform sites indicates that species composition is a combination of pelagic larval recruitment and attraction of adult fish from nearby natural reef habitats (Love et al 2006, Love et al 2003). The crux of whether platform ecosystems can serve as successful artificial reefs lies in which component in more prominent: production or attraction. Data collected at platform sites provides evidence supporting the theory that platforms may function as important nursery habitat for juvenile rockfish, including some species that are otherwise severely depleted throughout their range (Scarborough-Bull et al 2008, Rothbach 2007, Love et al 2006). Thus, platforms may be filling an important role in the ecosystem by providing additional habitat and allowing settlement by these species.

However, strong currents, threat of gear loss, and active oil operations have prevented recreational and commercial fishermen from frequenting these sites, thereby allowing the platforms to function as marine reserves (Scarborough-Bull et al 2008). The rigs-to-reefs movement in California has been spearheaded primarily by the recreational fishing industry with the understanding that upon conversion of these platforms into artificial reefs, they will be granted fishing access to the area (Schroeder and Love 2004). Once fishing pressure increases at the platforms, a habitat that is primarily producing additional species biomass may continue to contribute to the larger population and reduce fishing pressure at natural reefs, whereas a habitat that is primarily attracting organisms and detracting from settlement at natural reefs will function as a population sink (Love et al 2007, Danner, E.M., T.C. Wilson, and R.E. Schlotterbeck 1994).

Conclusions

If properly executed, rigs-to-reefs has the potential to be a beneficial component of California’s marine plan. The emphasis on artificial reefing in California has been on partial platform decommissioning over other options, which is likely a result of stakeholders, such as the oil industry, the state, and the recreational fishing industry, attempting to maximize their interests. The oil industry and the state both prefer partial decommissioning because it provides the greatest profits in the form of avoided decommissioning costs (COST 2010, McGinnis et al 2001). The recreational fishing industry prefers partial decommissioning because it is the only method that doesn’t require the use of explosives, thus leaving the existing ecosystem intact (Leidel 2002, Dauterive 2000).

Despite these arguments in favor of partial decommissioning, I recommend that the California Department of Fish and Game avoid using a one-size-fits-all artificial reef policy and, instead, assess platforms on a case-by-case basis as each platforms’ location, environmental conditions, and contribution to the regional hard substrate ecosystem is unique.

The platforms located in the Santa Barbara Channel are located in relatively shallow locations and receive warm waters from the southern California countercurrent, as well as colder waters from the northern California current, which allows settlement by both warm water and cool water species (Scarborough-Bull et al 2008, Love et al 2003, Casselle et al 2002, Love et al 1994). The platforms are located near each other and near natural hard substrate habitat, thereby forming a connective ecosystem and allowing movement between reefs. Furthermore, the proximity of the Channel Islands provides protection from open ocean dynamics and allows spillover from the recently established marine reserves located there (CINMS 2010).

The platforms located North of the Santa Barbara Channel, near Point Conception, are generally sited in deeper waters, and although a network of natural reefs surrounds the platforms, the location of the aggregated reef system is remote (Caselle et al 2002, Love et al 1994). These platforms experience cold waters transported by the California current, and open-ocean conditions, including periodic severe storm events (Love et al 1994).

The sites located offshore southern California, which have been the subject of considerably less scientific research, are located in shallow waters, likely receive warm water from the California countercurrent, and are probably afforded some measure of protection by the islands present there.

Based on these differences, it is evident that a thorough understanding of the ecological function of each site is essential to classifying its contribution to the region and enabling experts to identify changes in function resulting from changes in use. Platforms that are currently serving in a production capacity by creating additional habitat may become population sinks following decommissioning and a subsequent increase in fishing pressure. For example, platforms converted to reefs in the Santa Barbara Channel may absorb some of the fishing effort redistributed by the recent closure of traditional fishing grounds surrounding the Channel Islands (CINMS 2010). Comprehensive data and monitoring will highlight any changes and allow experts to address emerging issues in a timely manner (Wilding and Sayer 2002). To this end, I propose that the California Department of Fish and Game establish a biological monitoring program and begin collecting baseline data prior to commencing any platform decommissioning projects.

The biological monitoring objectives should aim to assess population stability at each site, and quantify the extent to which it contributes to fish production versus attraction. Suggested study designs intended to address these questions recommend periodic sampling at a frequency of 1 to 3 months to ensure that any temporal variations are recorded (Carassou et al 2007). Data collected should include measures of species abundance, growth over time, mortality rates, and movement (Brickhill et al 2005). These factors are essential to understanding population dynamics present at the platforms and determining whether these structures have a positive, negative, or neutral effect on the regional population. For example, a population that consists largely of juveniles, such as has been observed at platforms in the Santa Barbara Channel, implies that these sites facilitate settlement (Love et al 2007, Love et al 2006, Love et al 1994). Whether these populations contribute meaningfully to production depends on whether these organisms remain at the site, survive, and eventually, reproduce. Gathering these types of data would require that scientists either tag and track fish using a release and recapture method, or use a combination of genetics and otolith harvesting to create site-fidelity and age-frequency distributions (Carassou et al 2007, Brickhill et al 2005). While both of these options are cost and labor intensive, the results would provide much needed information. Another possible approach for determining site function is to incorporate control sites into the study, either in the form of nearby natural reefs or other artificial reefs, and monitor them simultaneously for related increases or decreases in fish abundance. This type of study is less expensive, less invasive, and can be conducted via telemetry or visual census, either by use of underwater cameras or scuba transects (Brickhill et al 2005).

Additionally, the biological monitoring program should include the execution of experiments designed to evaluate the risk of contamination from the oil well’s presence at the site. Thus far, little attention has been paid to the potential risks of maintaining an artificial reef at a former oil and gas production site. Drilling operations are known to release contaminants into the water, much of which is sequestered by the shell mound beneath the platform (Phillips, Salazar, Salazar, and Snyder 2006). However, the temporary containment of these toxins does not negate the fact that they are present in the environment and susceptible to resuspension, should the bottom be sufficiently disrupted (Phillips, Salazar, Salazar, and Snyder 2006, Schroeder and Love 2004). Very few studies examining whether the presence of these contaminants has any effect on the organisms have been completed; those that have indicate that the effect is negligible, but more research is needed to confirm these conclusions and ensure minimal environmental and human risk (Schroeder and Love 2004, Sayer and Baine 2002).

If science on the subject indicates that activities such as recreational fishing at decommissioned platforms is negatively affecting Pacific fish stocks by allowing the site to functioning as a population sink, the California Department of Fish and Game could address this issue by establishing marine protected areas at the sites. While this would undoubtedly enrage the recreational fishing industry, which has strongly supported the implementation of a rigs-to-reefs program, prohibiting consumptive uses would enhance the platforms' ability to foster fish populations and growth (Frumkes 2002, Roberts and Polunin 1993). Platforms that are closed to fishing may also provide an area for non-consumptive uses such as scuba diving. Recreational scuba divers have expressed interest in diving at the decommissioned oil and gas platforms; the sites offer divers a diverse and thriving ecosystem, and their use benefits natural marine resources by providing alternate dive sites and decreasing traffic at natural reefs struggling with degradation and in need of a chance to recover (Brock 1994, Stolk, Markwell, and Jenkins 2007).

The significant differences between existing social and ecological conditions in California and the Gulf States drastically reduces the applicability of the Gulf's successful rigs-to-reefs program to California's situation. Thus, California should approach the implementation of a rigs-to-reefs policy in its waters as a pilot project to inform future oil and gas decommissioning policy decisions. Decommissioning platforms for artificial reef establishment in California has potential as a useful fishery management tool, but in order to make it effective, each platform's role must be carefully considered. Platforms that are found to have a positive or neutral effect on regional fish populations prior to conversion into artificial reefs should be monitored following decommissioning to ensure that they do not become population sinks in response to increased fishing pressures. If such changes are noted following decommissioning, the platform should be designated a no-take zone and used for non-consumptive purposes to conserve its value as a fishery resource enhancement tool. Platforms that are found to have a negative effect on the surrounding environment prior to decommissioning should not be given rigs-to-reefs candidacy and should be completely decommissioned following the termination of oil production.

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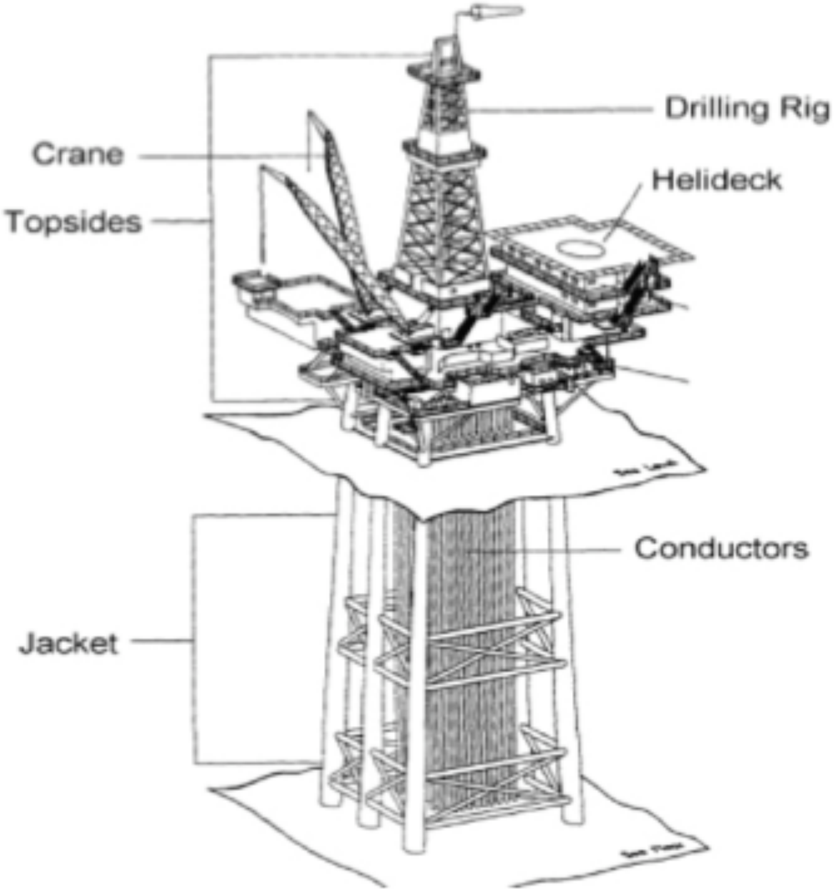
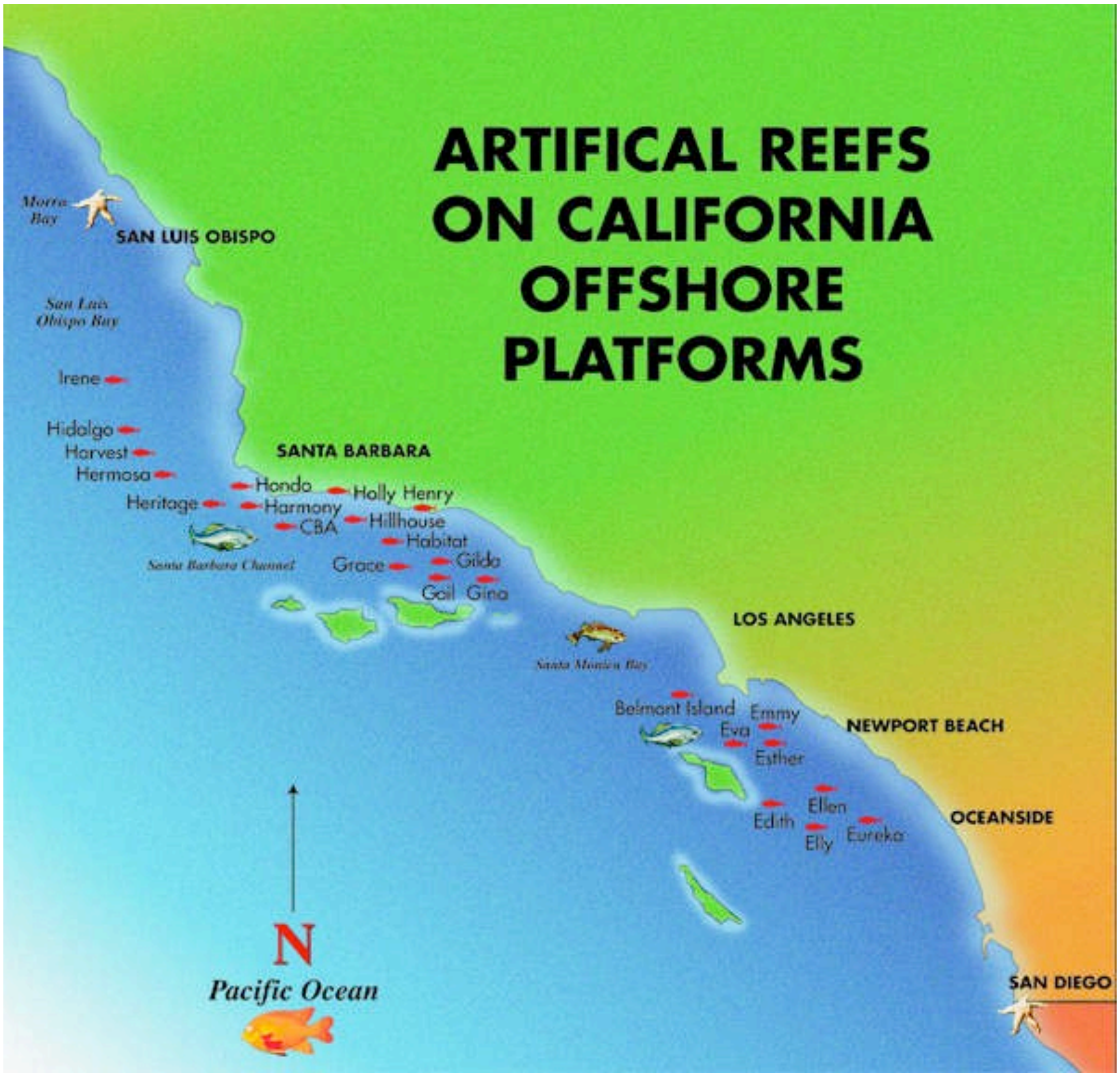
Appendix I: Anatomy of an Offshore Oil and Gas Platform

Image: COST 2010



Appendix II: Locations of Offshore Oil and Gas Platforms in California Waters

Image: preservereefs.org



Appendix III: Chart Displaying Water Depth and Weight of California Platforms

Image: COST 2010

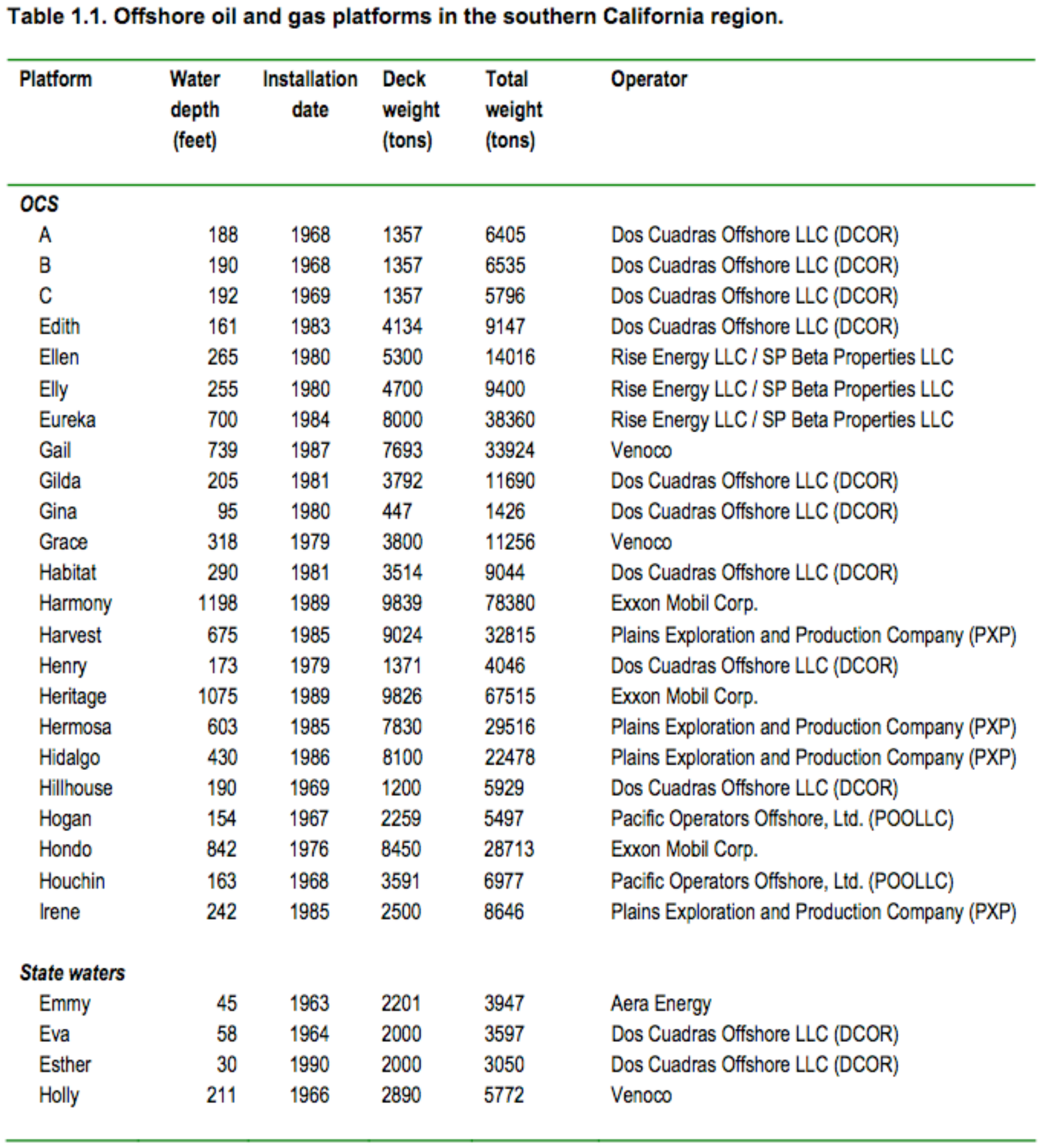


Table 1.1. Offshore oil and gas platforms in the southern California region.

Platform	Water depth (feet)	Installation date	Deck weight (tons)	Total weight (tons)	Operator
OCS					
A	188	1968	1357	6405	Dos Cuadras Offshore LLC (DCOR)
B	190	1968	1357	6535	Dos Cuadras Offshore LLC (DCOR)
C	192	1969	1357	5796	Dos Cuadras Offshore LLC (DCOR)
Edith	161	1983	4134	9147	Dos Cuadras Offshore LLC (DCOR)
Ellen	265	1980	5300	14016	Rise Energy LLC / SP Beta Properties LLC
Elly	255	1980	4700	9400	Rise Energy LLC / SP Beta Properties LLC
Eureka	700	1984	8000	38360	Rise Energy LLC / SP Beta Properties LLC
Gail	739	1987	7693	33924	Venoco
Gilda	205	1981	3792	11690	Dos Cuadras Offshore LLC (DCOR)
Gina	95	1980	447	1426	Dos Cuadras Offshore LLC (DCOR)
Grace	318	1979	3800	11256	Venoco
Habitat	290	1981	3514	9044	Dos Cuadras Offshore LLC (DCOR)
Harmony	1198	1989	9839	78380	Exxon Mobil Corp.
Harvest	675	1985	9024	32815	Plains Exploration and Production Company (PXP)
Henry	173	1979	1371	4046	Dos Cuadras Offshore LLC (DCOR)
Heritage	1075	1989	9826	67515	Exxon Mobil Corp.
Hermosa	603	1985	7830	29516	Plains Exploration and Production Company (PXP)
Hidalgo	430	1986	8100	22478	Plains Exploration and Production Company (PXP)
Hillhouse	190	1969	1200	5929	Dos Cuadras Offshore LLC (DCOR)
Hogan	154	1967	2259	5497	Pacific Operators Offshore, Ltd. (POOLLC)
Hondo	842	1976	8450	28713	Exxon Mobil Corp.
Houchin	163	1968	3591	6977	Pacific Operators Offshore, Ltd. (POOLLC)
Irene	242	1985	2500	8646	Plains Exploration and Production Company (PXP)
State waters					
Emmy	45	1963	2201	3947	Aera Energy
Eva	58	1964	2000	3597	Dos Cuadras Offshore LLC (DCOR)
Esther	30	1990	2000	3050	Dos Cuadras Offshore LLC (DCOR)
Holly	211	1966	2890	5772	Venoco